Chapter Comm 21

CONSTRUCTION STANDARDS

Note: Chapter Ind 21 was renumbered to be chapter ILHR 21, Register, February, 1985, No. 350, eff. 3-1-85. Chapter ILHR 21 was renumbered chapter Comm 21 under s. 13.93 (2m) (b) 1., Stats., and corrections made under s. 13.93 (2m) (b) 6. and 7., Stats., Register, January, 1999, No. 517.

Subchapter I — Scope

Comm 21.01 Scope.

The provisions of this chapter shall apply to the design and construction of all one- and 2-family dwellings.

Subchapter II — Design Criteria

Comm 21.02 Loads and materials.

Every dwelling shall be designed and constructed in accordance with the requirements of this section.

(1) DESIGN LOAD. Every dwelling shall be designed and constructed to support the actual dead load, live loads and wind loads acting upon it without exceeding the allowable stresses of the material. The construction of buildings and structures shall result in a system that provides a complete load path capable of transferring all loads from point of origin through the load-resisting elements to the foundation.

(a) Dead loads. Every dwelling shall be designed and constructed to support the actual weight of all components and materials. Earth-sheltered dwellings shall be designed and constructed to support the actual weight of all soil loads.

Dead Load of Insulation

To avoid ceiling drywall sag or related problems, attic insulation dead load should not exceed drywall manufacturer's recommended capacity. This is especially true today where heavy attic insulation and 24-inch truss spacing are common.

For example, one manufacturer, United States Gypsum, in its Gypsum Construction Handbook recommends that 3/8-inch drywall not be used to support insulation. They also specify that their other panel thickness may support insulation given the following load and framing spacing (drywall span) criteria:

Maximum Load	*Panel Thickness*	*Framing Spacing*
1.3 psf	*1/2 inch*	*24 inch o.c.*
2.2 psf	*1/2 inch*	*16 inch o.c.*
2.2 psf	*5/8 inch*	*24 inch o.c.*

Attic insulation materials vary in density and thermal properties. Therefore, the total weight per installed R-value will vary depending on type, installation method and manufacturer of insulation product. Some typical values are estimated below; check actual weights supplied from your manufacturer or installer.

Type	*Density*	*R/Thickness*	*R-38 Weight*	*R-50 Weight*
Cellulose	*2.4 pcf*	*3.6/inch*	*1.9 psf*	*2.8 psf*
Blown Mineral Wool	*1.2 pcf*	*2.8/inch*	*1.1 psf*	*1.8 psf*
Blown Fiberglass	*0.6 pcf*	*2.7/inch*	*.7 psf*	*1.0 psf*
Loose Fill Fiberglass	*1.1 pcf*	*2.5/inch*	*.7 psf*	*1.8 psf*
Fiberglas Batt R(19+19+13)	*0.7 pcf*	*3.2/inch*	*.6 psf*	*0.9 psf*

From the data above, most typical R-50 installations would exceed the capacity of 1/2-inch drywall on 24-inch o.c. framing unless the ½" drywall has been specifically designed for that purpose. However, 5/8-inch drywall on 24-inch framing (typical truss construction) would support most R-50 installations. Designers may want to check with the specific drywall manufacturer for span/load capacities when using 24-inch framing and high R-value cellulose installations. The above "USG" example indicates this may cause overloading.

(b) Live loads. 1. Floors and ceilings. Floors and ceilings shall be designed and constructed to support the minimum live loads listed in Table 21.02. The design load shall be applied uniformly over the component area.

TABLE 21.02

Component	Live Load (pounds per sq. ft.)
Floors	40
Garage floors	50
Exterior balconies, decks, porches	40
Ceilings (with storage)	20
Ceilings (without storage)	5

2. Snow loads. Roofs shall be designed and constructed to support the minimum snow loads listed on the zone map. The loads shall be assumed to act vertically over the roof area projected upon a horizontal plane.

Live Load - Snow

Exterior balconies or decks should be designed to withstand 40 PSF as the critical live load. Some designers have questioned if decks should be designed to withstand 70 PSF (40-occupant plus 30-snow). Such a design would be conservative, but not required.

The effect of drifting or sliding snow on a roof should be considered as a matter of good design practice. However, the UDC only requires a 30 or 40 PSF snow load applied uniformly to roofs. In complex roofs with side by side low-high portions or flat roofs below sloped upper roofs, a designer may want to consider potentially higher snow loads in the low roof areas where sliding or drifting snow may collect.

The UDC does not set lower snow live load values for roofs with glass or other slippery surfaces unless per s. Comm 21.27(1)(b), the slope is 7 in 12 or greater just as for other roof types. Otherwise, attached greenhouses, solar spaces, solar panels and other similar roof construction should be designed to withstand 40 or 30 PSF for zone 1 or 2 respectively.

(c) Wind loads. 1. Dwellings shall be designed and constructed to withstand a horizontal and uplift pressure of 20 pounds per square foot acting over the surface area.

2. Roof framing members spanning more than 6 feet measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using engineered clips, straps or hangers.

3. Roof framing members spanning 6 feet or less measured from the outermost edge of the roof shall be permanently fastened to the top plate of load bearing walls using toe-nailing, or engineered clips, straps or hangers.

Note: For information on toe-nailing, see the fastener schedule table in the appendix.

(d) Fasteners. All building components shall be fastened to withstand the dead load, live load and wind load.

Note: See the Appendix for a schedule of fasteners that will be acceptable to the department for compliance with this subsection. Other fastening methods may be allowed if engineered under s. Comm 21.02 (3).

Fasteners

Although the fastener schedule is part of the appendix and the code requires adequate fastening. The schedule presents one means of showing adequate fastening. Additionally, it may not be sufficient for certain designs.

Dwelling Anchorage

***Question**: When does a dwelling need to be anchored to the foundation?*
***Answer**: This section only discusses anchorage of the aboveground portion to the foundation. This is to prevent potential movement of the upper level due to wind pressure.*

Section 21.18 requires the top of the foundation wall to have adequate lateral bracing to the floor above, as through anchor bolts or other means. Where failures of foundations walls have occurred in the past, investigation has shown that many times damage could be attributed to lack of lateral support at the top of the walls rather than to faulty material or workmanship. In other cases, the use of a weak mortar in the masonry walls was an important contributing factor. The practice of some contractors backfilling basement walls before the first floor (lateral support system) is in place contribute to failures.

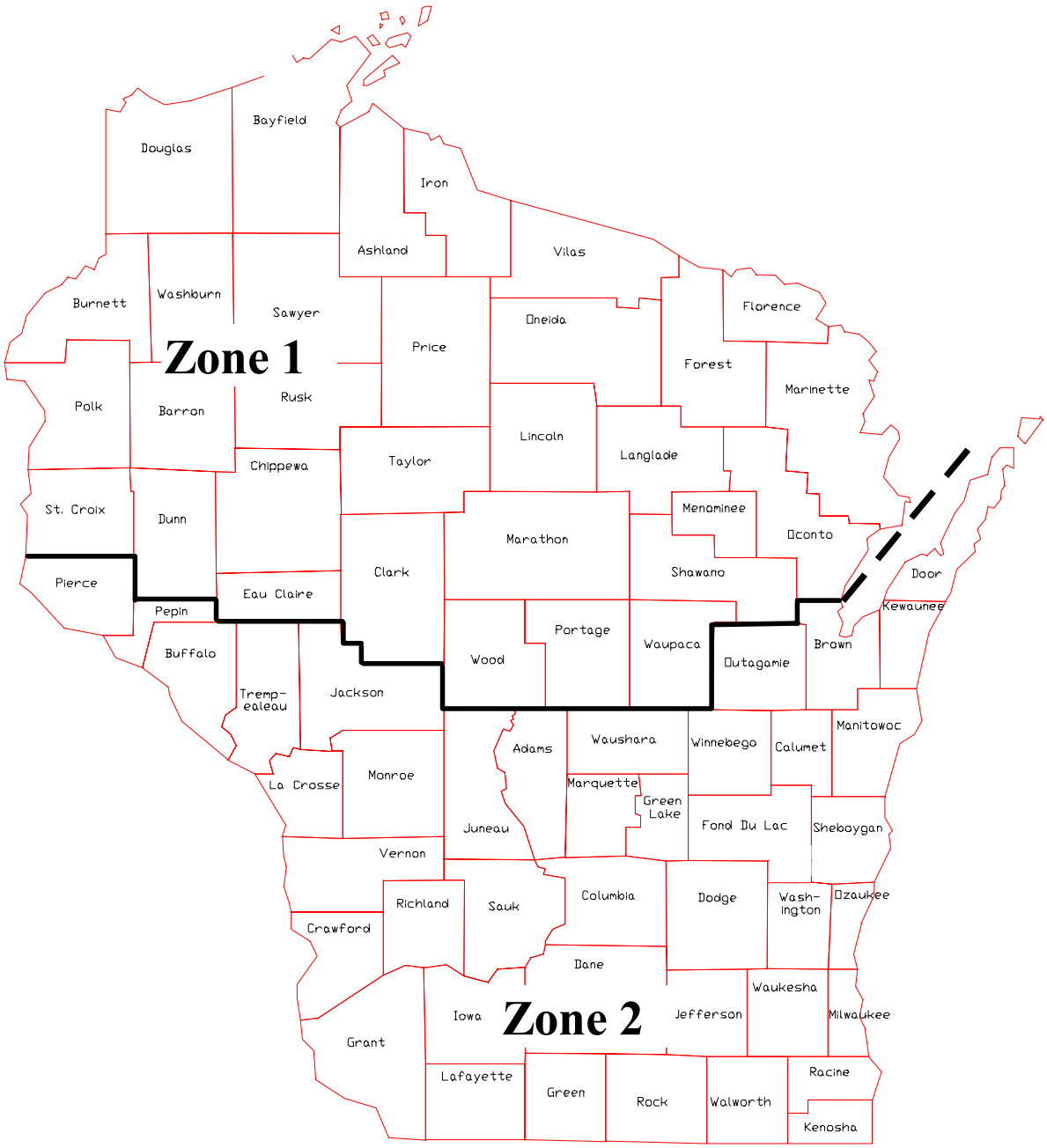
Section 21.22 (1m) also emphasizes that where sill plates are provided, the anchorage shall be continuous from the wall to the plate to the restraining floor system. This requires that solid bridging or blocking be installed between the rim joist and adjacent floor joist that run parallel to the foundation wall to transfer the loads on the wall.

Figure 21.02

ZONE MAP FOR ROOF LOADS

ROOF LIVE LOADS

Zone 1 - 40 PSF
Zone 2 - 30 PSF



(2) METHODS OF DESIGN. All dwellings shall be designed by the method of structural analysis or the method of accepted practice specified in each part of this code.

Note: See ch. NR 116, rules of the department of natural resources, for special requirements relating to buildings located in flood plain zones. Information regarding the elevation of the regional flood may be obtained from the local zoning official.

"Typical" Structural Analysis

Question: *A builder submits a building plan and includes "typical" structural calculations prepared and stamped by an architect or engineer. Is there any time limit placed on the acceptability of such "stamped" calculations?*

Answer: *Usually the typical calculations correspond to a master plan of a home built repetitively. When reviewing the building plans, you should verify that the loading conditions, spans, member sizes, member spacing and lumber grade as specified in the "typical" calculations are consistent with the plans. The use of such typical calculations or span tables (as in the Appendix to Ch. 21) is generally acceptable as long as the design criteria coincide with the building plans. There would be no time limit on the use of such calculations as long as they do not conflict with the requirements of the current code. An update of the calculations should be required if the code changes and different loads, load duration factors or other design criteria become effective.*

(3) STRUCTURAL ANALYSIS STANDARDS. Structural analysis shall conform to the following nationally recognized standards.

(a) Wood. 1. Except as provided in subpar a. and b., structural lumber, glue-laminated timber, timber pilings and fastenings shall be designed in accordance with the "National Design Specification for Wood Construction" and the "Design Values for Wood Construction," a supplement to the National Design Specification for Wood Construction.

a. Section 2.2.5.3. The cumulative effects of short-time loads, such as snow, shall be considered in determining duration of load. For snow load, no greater duration of load factor than 1.15 shall be used.

b. Section 4.1.7. The provisions of this section shall also apply to reused lumber. Reused lumber shall be considered to have a duration of load factor of 0.90.

2. Span tables for joists and rafters printed in the appendix or approved by the department may be used in lieu of designing by structural analysis.

(b) Structural steel. The design, fabrication and erection of structural steel for buildings shall conform to Specification for Structural Steel Buildings, Allowable Stress Design and Plastic Design and the provisions of the accompanying commentary as adopted under s. Comm 20.24 (3).

(c) Concrete. Plain, reinforced or prestressed concrete construction shall conform to the following standards:

1. ACI Std. 318, "Building Code Requirements for Reinforced Concrete."

2. ACI Standard 318.1, "Building Code Requirements for Structural Plain Concrete."

(d) Masonry. The design and construction of masonry shall conform to the provisions of the Concrete Masonry Handbook for Architects, Engineers, Builders as adopted under s. Comm 20.24 (15).

(e) Engineered structural components. Engineered structural components shall be used in accordance with structural analysis or with load tables supplied by the manufacturer, provided those load tables were developed using structural analysis or load testing.

Manufacturer's Recommendations

The Uniform Dwelling Code, s. Comm 21.02(2), requires that all dwellings be designed by the method of structural analysis or the method of accepted practice. It is accepted practice to install a material in a manner recommended by the material's manufacturer, if the installation is regulated by the code. A material installed in a manner that is inconsistent with the manufacturer's recommendation should not be allowed unless additional information is provided showing that the none recommended installation will still meet the performance requirement of the code. An example is listed equipment--if the equipment is not installed per manufacturer instructions, the listing is not applicable. A manufacturer's recommendation must also be checked for compliance with the Uniform Dwelling Code. It is the responsibility of the builder to have manufacturer's installation instructions available for review by the inspector (per s. Comm 20.09) when a question of proper installation arises.

Log Homes

The UDC does not have a specific code section on log home construction; however, log homes are often engineered and kit-produced by a manufacturer. In that case, their requirements should be followed. We have also adopted the log home construction standards in Comm 20.24. In the appendix of this commentary, we have reprinted one group's general guidelines for log homes that may be useful to you or you can download the entire adopted standards.

Roof and Floor Trusses

It is the responsibility of the inspector to verify conformance of the dwelling through the plan review process and the inspection process. It is recommended that builders or truss manufacturers demonstrate code conformance of their product to the building inspector in one of the two following manners:

1. *DIRECT APPROVAL* *In this situation, the builder provides the structural drawings and calculations for the truss or building component directly to the building inspector for the inspector's review. The code does not require that structural drawings or calculations be provided by a professional engineer or architect. The building inspector may review structural drawings and calculations for code compliance. Structural drawings and calculations are commonly sealed and signed by a professional engineer or architect and are generally considered as complying with the code.*

   All structural drawings and calculations shall conform to s. Comm 21.02(3) structural analysis standards.

2. *MATERIAL EVALUATION NUMBER* *Under this method, the manufacturer of the building component submits drawings and calculations to the Department of Commerce. The Department would review the drawings and calculations and issue an evaluation number to the manufacturer. The manufacturer provides the shop drawings with the appropriate evaluation number to the builder and/or inspector. These evaluation numbers will also be supplied independently to the inspection offices from the department by way of the Material Evaluation Notices. This will serve as a means of cross-referencing the numbers to the manufacturer and the trusses.*

   With this method, the building inspector has to rely on the shop drawing provided by the manufacturer to determine whether or not the product on the construction site conforms to the standards. The inspector would compare the shop drawing to the truss to verify that the same quality and size of lumber, connection plates, etc., were being provided as were approved on the shop drawing. The background structural calculations need not be repetitively submitted.

Engineering Terms Used in the Code or Referenced Standards

1. *ALLOWABLE STRESS (F)*
   - *Determined by physical testing of wood specimens of different grades and species.*
   - *Tabulated value already has a built in factor of safety.*
   - *Historically done by visual inspection of wood for defects (knots, checks.....) = Visual Graded.*
   - *Also can be done by machine by testing deflection-vs-load = Machine Stress Rated (MSR).*

2. *LATERAL SUPPORT*
   - *Structural bracing or interconnection that prevents movement of a structural member in a specific direction, usually perpendicular to the direction that the main structural member is providing support.*
   - *Examples:*
     - *bridging to joists*
     - *corner bracing to studs (let-in 1 x 4, metal straps, plywood panels)*
     - *subfloor to joists*
     - *sheathing to trusses*
     - *floor system to foundation walls*

- *basement floors to foundation walls*

3. *MODULUS OF ELASTICITY (E)*
   - *Ratio of stress/strain.*
   - *For a given force applied to a material, you can predict the deformation if you know E.*

4. *MOMENT*
   - *Force x distance (inch-lbs).*
   - *Causes curvature deformation in beams or columns.*
   - *Causes tension and compression stresses in beams and sometimes columns.*

5. *MOMENT OF INERTIA (I)*
   - *Used in the calculation of beam deflection.*
   - *Geometric property of a structural member.*
   - *$I = \frac{bd3}{12}$, inches4 (rectangular beam), b = width, d = depth*

6. *SECTION MODULUS (S)*
   - *Geometric property of a structural component (beam, column . . .).*
   - *S = M/Fb, inches3*
   - *$S = \frac{bd2}{6}$ (rectangular beam), b = width, d = depth*

7. *STRAIN*
   - *Deformation, (stretching, compaction, curvature) caused by an external force.*

8. *STRESS* - Internal resistance to an external force.*
   - Generally in lbs/in2 (psi).

- Fb = bending stress;
Resists curvature due to bending moment (Force).

- Fc,t = axial compression or tension stress;
Resists perpendicular compaction or stretching due to a longitudinal force.

- Fv = shear stress;
Resists slippage in plane of the surface parallel to the end face of the beam.

**Capitol (F) denotes "allowable" stresses in a material samples as determined by testing. Small case (f) denotes "actual" calculated stress of a structural member as based on design loads.*

Structural Analysis Standards - Wood

The following code-referenced standards shall be used in the design of roof and floor trusses.

The 2001 edition of the "NATIONAL DESIGN SPECIFICATIONS FOR WOOD CONSTRUCTION" and its supplement, "DESIGN VALUES FOR WOOD CONSTRUCTION," as published by the National Forest Products Association.

The "DESIGN SPECIFICATIONS FOR METAL PLATE CONNECTED WOOD TRUSSES" TPI-85 as published by the Truss Plate Institute, Inc.

The department has determined that the design minimum live load in Table 21.02 for ceilings with storage of 20 PSF applies to stick-built frame construction. Roof trusses designed in accordance with TPI-85 for attic storage loading will meet the intent of the code, only if such design criteria has been identified on the truss and drawings.

Outline of the National Design Specification (NDS)

This specification is adopted by the UDC s. Comm 20.24(2)(a) and s. Comm 21.02(3)(a). The NDS is used for structural design of wood members as an alternative or in addition to the prescriptive (accepted practice or "cookbook") standards in Ch. 21. It is the basis for the development of the Fastener and Span Tables in Appendix A-21 of the UDC. Its accompanying NDS Supplement provides allowable stress values depending on grade, species and dimensions of lumber used. It is also the basis for "Design Values For Joist And Rafters-Visual Grading" tables in Appendix A-21.

NDS Part I General Requirements for Structural Design

- *Includes guidelines for use of NDS considering the effects of:*
  - *Bracing*
  - *Connections at Joints*
  - *Adequate Load Assumptions*
  - *Most Conservative Load Combinations*

- *The NDS is intended to be adopted by governing codes such as the UDC which may prescribe the above minimum load and load combinations.*

NDS Part II Design Values

- *Allows for modification of design stresses due to:*
  - *moisture conditions*
  - *temperature*
  - *preservative treatment*
  - *fire retardant treatment*
- *Duration of load.*

Not all stress modifications are necessarily applicable to all beam and column installations.

Introduces the concept of a Load Duration Factor (LDF). The LDF will adjust allowable stresses, generally upward, to recognize that wood is more responsive in resisting short term loadings.

- *Floor Live Load = 1.0 (10 yr)*
- *Snow Load = 1.15 (2 mo.)*
- *Roof Live Load = 1.25 (7 day)*
- *Earthquake, Wind = 1.33 (1 day)*
- *Impact = 2.00 (2 sec)*

NDS Part III General Design Provisions and Formulas

1. *Beam Design*
   - *Formulas listed in text (also see s. 21.18(3) of this commentary).*
   - *Notching of beams - limitations similar to UDC.*
   - *In general, the NDS assumes rectangular sections (sawn lumber) are used. Certain modification factors can be used for other shaped (round) members. Also, other shaped members will have different geometric properties that will alter the "typical" formulas referenced in this commentary.*

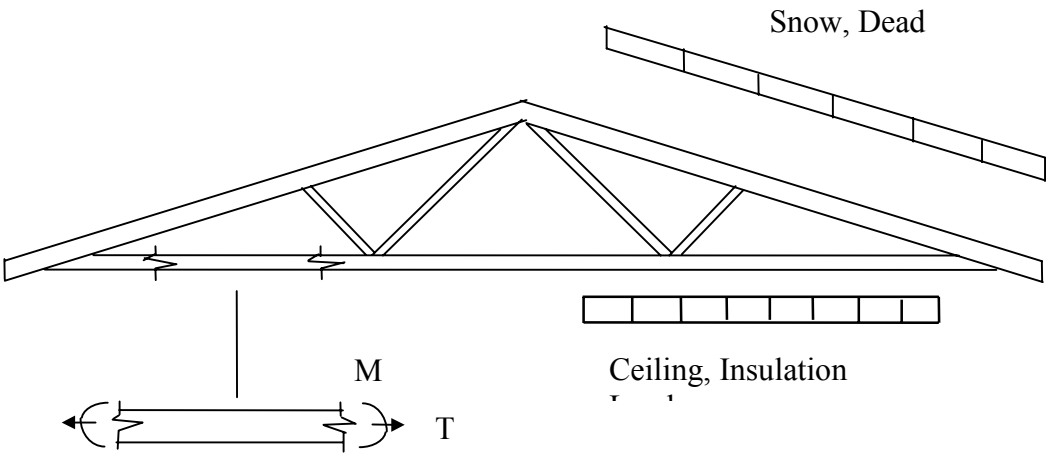
   - *Beam formulas can be complicated by and thereby adjusted to compensate for:*
     - *lack of lateral support*
     - *relatively long beam length*
     - *beam shape: round, rectangle, diamond*

   - *Beam design must also consider:*
     - *Shear stress (fv), especially for heavily loaded members.*
     - *Deflection considerations, especially for long spans or when the joist/beam depth is relatively small.*

2. *Column Design, Axial Compression (C)*
   - *Formulas listed in NDS.*
   - *Compression members can be horizontal or vertical (trusses).*
   - *Column design is a function of:*
     - *Area*
     - *Compressive Stress, fc*
     - *Column length, l*
     - *Column width, d*
     - *Shape: round, square, tapered*
     - *There is no one simple formula because of the many interrelated factors listed above.*

3. *Tension Members, Axial Tension (T)*
   - *Formulas listed in NDS.*
   - *Member design is a function of:*
     - *Area*
     - *Tensile stress, ft.*
     - *Usually end connections are most critical in design.*

4. *Combined Axial (T or C) & Bending Stress*
   - *Common in truss design and pole buildings.*



Member
Stresses: Axial Tension and
Bending Moment

- *Formulas listed*
- *Simplest case:*

fb + ft(c)
Fb Ft(c) less than or equal to 1.0

f = actual member stress
F = allowable member stress

- *This means that the sum of the percentage of actual bending tension (or compression) stress plus the percentage of actual axial tension (or compression) stress should be less than 100 percent of allowable tension (or compression) stress. That is, allowable stress equals the sum of the contributions from bending plus axial allowable stresses.*

NDS Part IV Sawn Lumber

- *Refers to design values given in NDS Supplement. Allowable stresses differ depending on single-vs-repetitive member use.*

- *Single member use*
  - *individual member responsible for carrying entire load*
  - *example: beam, column*
  - *no "near neighbors" to share load*

- *Repetitive member use*

- *bending members only*
- *spaced 24 in. o.c. or less*
- *not less that 3 in number*
- *joined by floor or roof decking to spread load to adjoining members*
- *example: joists, rafters, trusses, built up beams*

NDS Part V Structural Glued Laminated Timber

(Also see further information in this commentary section.)

- *General Design Values based on visual and machine stress rated methods given in Tables 5A, 5B and 5C of the NDS Supplement.*

- *Design values can be modified due to service condition, etc., similar to those specified in Part II.*

- *Curved glued laminated members (arches) are possible and special consideration is specified.*

- *Glued laminated members subject to compression or combined tension-compression are designed per Part III with some additional requirements.*

NDS Part VI Round Timber Piles

- *Rarely used for UDC construction.*

- *Specifies types of preservative treatment, typical dimensional requirements per American Wood Preservers Association (AWPA) and ASTM standards.*

- *Design values and modification factors based on service condition, size and condition of preservative treatment.*

NDS Part VII Structural Assemblies

- *References American Panel Association (APA) documents, "Plywood Design Specification" and "Diaphragms" for design and construction recommendations of structural assemblies consisting of panel products.*

NDS Part VIII Wood Fastenings

- *Tables give design values, load per fastener, for:*
  - *nails (common, box, etc., with minimum diameters)*
  - *screws (lag, wood)*
  - *bolts*
  - *split rings*
  - *metal plates*
- *This information is used to develop the fastener table in UDC Appendix.*

NDS Supplement: Design Values

- *Depending upon species, grade, and size classification, design values are provided for various loading situations:*

  Fb - Allowable bending stress, psi
  Fc - Allowable compressive stress (parallel to grain), psi
  Fcl- Allowable compressive stress (perpendicular to grain), psi
  Ft - Allowable tension stress, psi
  Fv - Allowable shear stress, psi
  E - Modulus of Elasticity, psi

- *Some values also reprinted here based on the 1991 NDS.*

Note: See Appendix for complete tables for all species and values.

Overview Of Important Issues Regarding Trusses

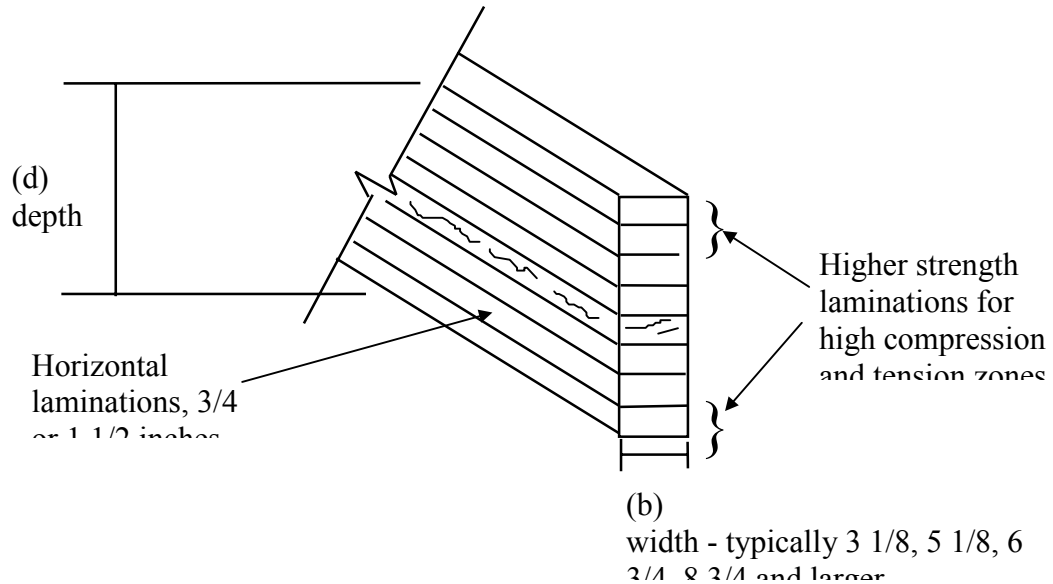
1. *Per s. Comm 21.02(3), Note #1*
   Trusses should conform to TPI-85, "Design Specification For Metal Plate Connected Wood Trusses."

2. *Per s. Comm 20.09(4)(a)*
   The designer may be required to submit plans showing the truss design is consistent with or shows:
   - *house framing plan*
   - *bearing and connection/anchorage details*
   - *design loads*
     - *top and bottom chord load*
     - *live, dead, wind load*
     - *concentrated or nonuniform loads*
   - *outside configuration of components*
   - *permanent bracing system if required*
   - *connector plate size per joint*

3. *Per s. Comm 20.09(4)(b)*
   The designer may be required to submit data including:
   - *stress calculations*
     - *axial*
     - *bending*
     - *combined*
   - *species, grade, size of members*
   - *member forces*
   - *reactions*
   - *connector plate capacity required per joint*

Additional Background Information Glue Laminated Timber[1]

1. *Used for long spans, large loads and architectural effect.*
2. *Relatively thin laminations of wood combined to practically any length and size.*



3. *Relatively higher structural properties.*
   - *Laminations of high quality wood*
   - *Defects - Knots etc., spread out, not continuous for depth or width of member*
   - *Maximum 2600 psi bending stress = F_b, compared to 1900 psi for sawn lumber*

4. *Glue generally for wet use applications with some dry use glue allowed, but not common.*

5. *Graded differently than sawn lumber.*

   - *24F indicates allowable bending stress = 2400 psi under normal conditions.*
   - *V1, V2 etc., refers to Visual Graded No. 1 or 2.*
   - *E1, E2 refers to Machine Grading by testing the Modulus of Elasticity.*

6. *Some condition of use and load duration adjustment factors may apply.*

7. *Design properties are included in the NDS Supplement.*

(1) Source: Breyer, Donald E., Design of Wood Structures, Mc Graw Hill, 1980.

<u>Used and Ungraded Lumber</u>

1. *<u>Used Graded Lumber</u>*

Sound used lumber with grade marks still identifiable may be used for one- and two-family dwellings as follows:

(1) The published NDS allowable design stresses for the lumber species and grade represent values for new lumber. To apply to used lumber, these must be reduced to a 90 percent value. NOTE: For joists and rafters, use "F_b" for

repetitive-member use under normal duration load conditions. These used, 90 percent reduced bending values should not be increased using LDF's for snow or construction loading conditions.

(2) The span tables for joist and rafters in the appendix of the code may be used with the reduced design stresses.

2. Used Ungraded Lumber and Used Resawn Graded Lumber

Sound used non graded and sound used re-sawn graded lumber may be used for one- and two-family dwellings using method (1a) or (1b) below to determine allowable design stresses at 19 percent moisture content.

(1a) The used non graded or used re-sawn graded lumber must be graded based on the re-sawn and certified in accordance with nationally recognized lumber grading rules for visually graded lumber per ASTM D245. Agencies publishing grading rules are listed in the NDS "Design Values for Wood Construction."

(1b) Alternative Method - Use the NDS published allowable design stresses for lumber species using No. 3 or utility grades for studs, rafters and joist and No. 1 grade for beams, stringers, post and timbers in lieu of certified graded or re-graded lumber.

(2) The published NDS allowable design stresses for the lumber species and grade for certified graded lumber or the No. 3, utility and No. 1 grades must be reduced to a 90 percent value. NOTE: For joist and rafters use "Fb" for repetitive-member use under normal duration load conditions. These reduced bending values should not be increased using LDF's for snow or construction loading conditions.

(3) The span tables for joist and rafters in the appendix of the code may be used with the reduced design stresses.

3. Native Sawn Ungraded Lumber

Sound native sawn un-graded lumber may be used for one- and two-family dwellings using method (1a) or (1b) below to determine allowable design stresses at 19 percent moisture content.

(1a) The native sawn lumber must be graded and certified in accordance with nationally recognized lumber grading rules for visually graded lumber per ASTM D245. Agencies publishing grading rules are listed in the NDS "Design Values for Wood Construction."

(1b) Alternative Method - Use the NDS published allowable design stresses for the lumber species using No. 3 or utility grade for studs, rafters, and joist and No. 1 grade for beams, stringers, post and timbers in lieu of certified graded lumbers.

(2) The span tables for joist and rafters in the appendix of the code may be used with the allowable design stresses for graded or No. 3 utility and No. 1 grade lumber. NOTE: For joist and rafters use "Fb" for repetitive-member use and for beams, stringers and timbers use "Fb" for single-member use. These allowable bending values may be increased using LDF's of 15 percent for snow or 25 percent for construction loading conditions in accordance with NDS.

(3) For lumber species not listed in the NDS "Design Values for Wood Construction" and where nationally recognized allowable design stresses are not available, structural testing of the materials will be required. Testing must be conducted by a recognized independent testing agency in accordance with the appropriate ASTM load test procedure. The cost of such testing shall be borne by the person applying for the building permit.

The department will accept lumber species design stresses recommended by the U.S. Forest Products Laboratory, Madison, Wisconsin.

4. <u>References and Definitions</u>

A. NDS - The "National Design Specification for Wood Construction" (NDS) and its supplement "Design Values for Wood Construction" 1997 editions as published by National Forest Products Association. Comm 20.24(2)(a).

B. <u>Sound lumber</u> is defined as materials without structural damage such as splits, cracks, gouges, saw , rot or insect damage and with notching and borings limited as follows:

- *Notching and boring of members shall be limited to that permitted in Ch. Comm 21 for floor, wall, ceiling and roof members.*

  (1) Beams, girders and joists - s. Comm 21.22(5)
  (2) Columns, posts and studs - s. Comm 21.25(4)
  (3) Rafters and ceiling joists - s. Comm 21.28(6)

C. <u>Unsound framing (structural) lumber</u> shall not be used in one- and two-family dwellings.

<u>T-30 and T-50 Lumber</u>

It has been brought to our attention that lumber products using the designations of T-30 and T-50 are being used in Wisconsin. These 2" x 4" spruce-pine-fir lumber products designated by Weyerhaeuser as T-30 and T-50 are taken from machine stress rated stock graded 1450-1.3E and 1800-1.6E, respectively. These new designations are intended to take advantage of better than average lumber within the stress grade level as well as more accurate stress grading procedures and equipment.

The following allowable stresses (in PSI) associated with these products are approved for use in Wisconsin.

Grade	*F_b*	*F_t*	*F_c*	*MOE*
T-30	*1450*	*800*	*1150*	*l,300,000*
T-50	*1800*	*1175*	*1450*	*l,600,000*

Any design values differing from the above are not to be accepted without complete test data from an approved testing lab wherein ASTM procedures are followed.

These products do not require a material approval as this is not a new construction material or new assembly.

Comm 21.03 Exits, doors and hallways.

Exits, doors and hallways shall be constructed as specified in this section.

(1) EXITS FROM THE FIRST FLOOR. (a) Except as allowed under par. (h), every dwelling unit shall be provided with at least 2 exit doors accessible from the first floor.

(b) At least one of the exits shall discharge to grade. This exit may include interior or exterior stairs.

(c) An additional exit may discharge to an outside balcony that complies with sub. (10).

(d) An additional exit may discharge into an attached garage provided the garage has an exit door that discharges to grade. An overhead garage door may not be used as an exit door.

(e) Except as allowed under pars. (f) and (h), the 2 required exit doors shall be separated by at least the greater of the following distances:

1. One-third the length of the longest diagonal of the floor in plan view, exclusive of an attached garage.

2. 20 feet.

Note: See appendix for examples of exit separation design.

(f) 1. First floor levels that do not meet the separation requirements under par. (e), shall have at least one egress window complying with sub. (6) on that floor level.

2. An egress window to comply with subd. 1. shall be separated from at least one door on the first floor by one of the distances under par. (e).

3. If first floor levels that do not meet the separation requirements under par. (e) contain one or more sleeping rooms, each sleeping room shall have at least one egress window complying with sub. (6).

(g) 1. The exit separation distance required under par. (e) shall be calculated or measured as a straight line from the midpoint of one doorway to the midpoint of the other doorway.

2. For exiting through an attached garage, the separation distance shall be measured using the door connecting the garage and the dwelling. Distance within the garage shall be ignored.

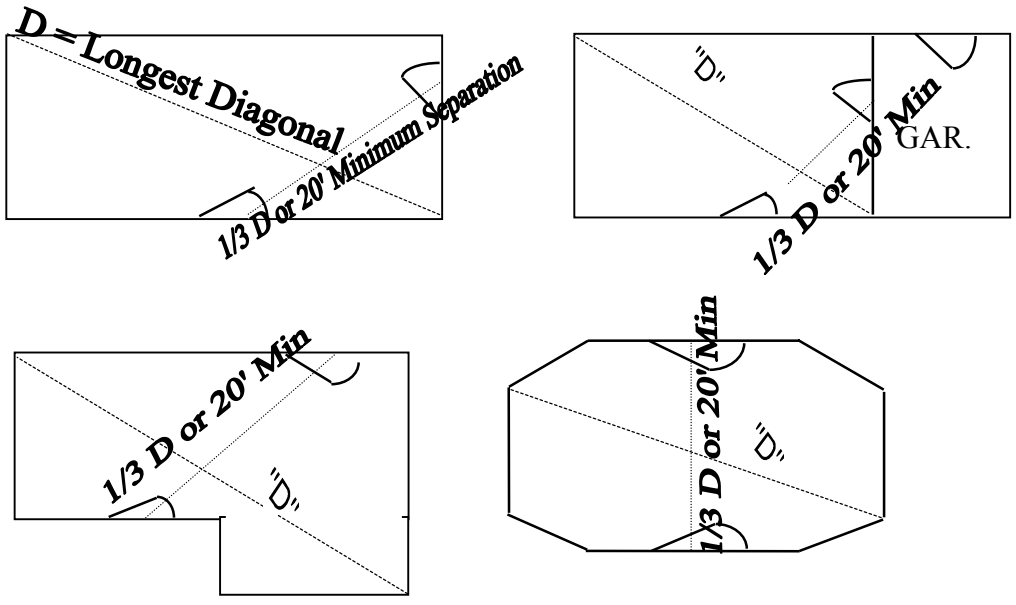
(h) 1. Dwellings consisting of no more than a first floor with a maximum floor area of 250 square feet and a loft area not exceeding half of the first floor area, shall be provided with at least one exit door leading directly to the exterior and at least one egress window that complies with sub. (6).

2. a. Dwellings that meet the size restrictions under subd. 1., are not required to meet the exit separation requirements under subs. (e) or (f).

b. If a dwelling that meets the size restrictions under subd. 1., has more than one room on the first floor, the door and the egress window shall be located in different rooms.

Separation of Exits

Note that these sections require the two required exits to be separated a distance of at least one-third the longest diagonal measurement in plan view of that floor or at least 20 feet (see diagrams).



ss. Comm 21.03(1), (e) 1., & (e) 2.
SEPARATION OF EXITS

Acceptable First Floor Exits

Question: *Is it acceptable to use a ground floor exit door to help satisfy the requirement for two exits from a first floor?*

Answer: *Yes, assuming the two floors are connected with a stairway and the other requirements are met.*

Earth-Sheltered Dwellings

Per the definition of first floor in s. Comm 20.07(34e), there is always a first floor, so a single-story (first floor) earth sheltered dwelling requires two exits per this section. Egress windows may not be used to satisfy requirement. See sections 20.07(34e) and 20.10(1)(b)4.a. of this commentary for further discussion.

Question: *Are first floor bedrooms required to have egress windows?*

Answer: *No. The code indicates two exits are required from the first floor; however, if the exit separation requirements are not met then any first floor bedroom would require egress windows. The code further allows the use of egress windows in lieu of the second exit requirement from second floor* ***or*** *basement.*

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Bedroom Exit Windows

Question: *Can egress windows be located in sitting or dressing areas of a master bedroom suite?*

Answer: *This section requires egress windows in some bedrooms. However, it does not specify location of the window within the bedroom itself. A sitting room or area located in an alcove of a master bedroom is an acceptable location for the bedroom egress window. The alcove can be considered part of the bedroom if there are no doors obstructing communication between the two areas.*

(2) EXITS FROM THE SECOND FLOOR. (a) At least 2 exits shall be provided from the second floor. One of the exits shall be a stairway or ramp and lead to the first floor or discharge to grade. The second exit may be via a stairway or ramp which discharges to grade or may discharge to a balcony which complies with sub. (10).

(b) Except as provided in par. (c), windows which comply with sub. (6) may be provided in each second floor bedroom in lieu of the second exit from the floor.

Question: *If one of the second floor bedrooms has a code-compliant exit door out of the bedroom onto a deck or balcony, can the requirement for egress windows in the other bedrooms be waived?*

Answer: *Yes, but only if the hardware on the bedroom door, which leads to the second exit is incapable of being locked from the hallway that serves as the exit path from these other bedrooms .See chapter 20.07 for 'EXIT' definition.*

(c) Where the second floor is the lowest floor level in a dwelling unit, as in an up-and-down duplex, windows may not be provided as the second exit from the floor.

(3) EXITS ABOVE THE SECOND FLOOR. At least 2 exits shall be provided for each habitable floor above the second floor. The exits shall be located such that in case any exit is blocked some other exit will still be accessible to the second floor. The exits shall be stairways or ramps that lead to the second floor or discharge to grade.

Acceptable Exits Above the Second Floor

Only stairways or ramps to the second floor or grade are acceptable to meet the two exit requirements. If the bottom of this stairway terminates at the second floor there must be a door leading back into the dwelling to complete the exit path. The stairway may not discharge onto a roof at the second floor level without a level landing and egress into the second floor. Egress windows or a balcony may not be used.

Exits from Attics

***Question**: Does the requirement for two exits for floors above the second floor apply to walk-up attics?*

***Answer**: No - it would only apply to habitable spaces including offices, playrooms or other conditioned spaces (see Comm 22.06(5)) that may be occupied. Since attics are not considered habitable spaces they need not have natural light and ventilation nor multiple electrical outlets or lights unless they are used for mechanical equipment or electrical equipment.*

(4) EXITS FROM LOFTS. (a) At least one stairway exit shall be provided, to the floor below, for a loft exceeding 400 square feet in area.

(b) At least one stairway or ladder exit shall be provided to the floor below for a loft, 400 square feet or less, in area.

Exits from Lofts

A code-complying loft is not subject to the exiting requirements of the other subsections of this section. In other words, a loft open to a first-floor below, only requires a single stairway or ladder (depending on area) to satisfy exiting. A loft bedroom or loft level would not require an egress window but would require natural light and ventilation the same as any other habitable space. See s. Comm 20.07(50) of the code and this commentary for a discussion of what is considered "open to the floor below."

(5) EXITS FROM BASEMENTS AND GROUND FLOORS. (a) General. Except as provided in par (b), all basements and ground floors shall be provided with at least one exit of the following types:

1. A door to the exterior of the dwelling.

2. A stairway or ramp that leads to the floor above.

(b) Basements and ground floors used for sleeping. 1. Basements and ground floors used for sleeping shall be provided with at least 2 exits.

2. The exits shall be located as far apart as practical.

3. The exits may not be accessed from the same ramp or stairway.

4. In addition to the exit type required under par. (a), the second exit from a basement or ground floor used for sleeping shall be one of the following types:

a. A door to the exterior of the dwelling.

b. A stairway or ramp that leads to the floor above.

c. A stairway that leads to a garage provided the garage has an exit door other than the overhead door.

d. An egress window that complies with sub. (6), located in each bedroom.

(6) WINDOWS USED FOR EXITING. Windows which are installed for exit purposes shall comply with the requirements of this subsection.

(a) The window shall be openable from the inside without the use of tools or the removal of a sash. If equipped with a storm or screen, it shall be openable from the inside.

(b) 1. The nominal size of the net clear window opening shall be at least 20 inches by 24 inches irrespective of height or width. Nominal dimensions shall be determined by rounding up fractions of inches if they are 1/2-inch or greater or rounding down fractions of inches if they are less than 1/2-inch.

2. No portion of the window, including stops, stools, meeting rails and operator arms, shall infringe on the required opening.

(c) The area and dimension requirements of par. (b) may be infringed on by a storm window.

(d) 1. For any window used for exiting, the lowest point of clear opening shall be no more than 60 inches above the floor.

2. If the lowest point of clear opening is more than 46 inches above the floor, a permanent platform or fixture shall be installed such that a flat surface at least 20 inches wide and 9 inches deep is located no more than 46 inches directly below the clear opening.

3. The topmost surface of the platform or fixture shall be no more than 24 inches above the floor.

4. The topmost surface of the platform or fixture shall support a live load of at least 200 pounds.

5. A step used for the sole purpose of reaching the top of the platform or fixture is exempt from the requirements of s. Comm 21.04.

(e) 1. An egress window with any point of clear opening below adjacent grade shall be provided with an areaway in accordance with this section.

2. The width of the areaway shall be at least equal to the width of the window.

3. The areaway shall be a minimum of 36 inches measured perpendicular from the outer surface of the below-grade wall.

4. If the bottom of the areaway is more than 46 inches below adjacent grade or the top of the areaway enclosure, the areaway shall be provided with a ladder or at least one additional step to aid egress. Steps used to comply with this section are exempt from the requirements of s. Comm 21.04.

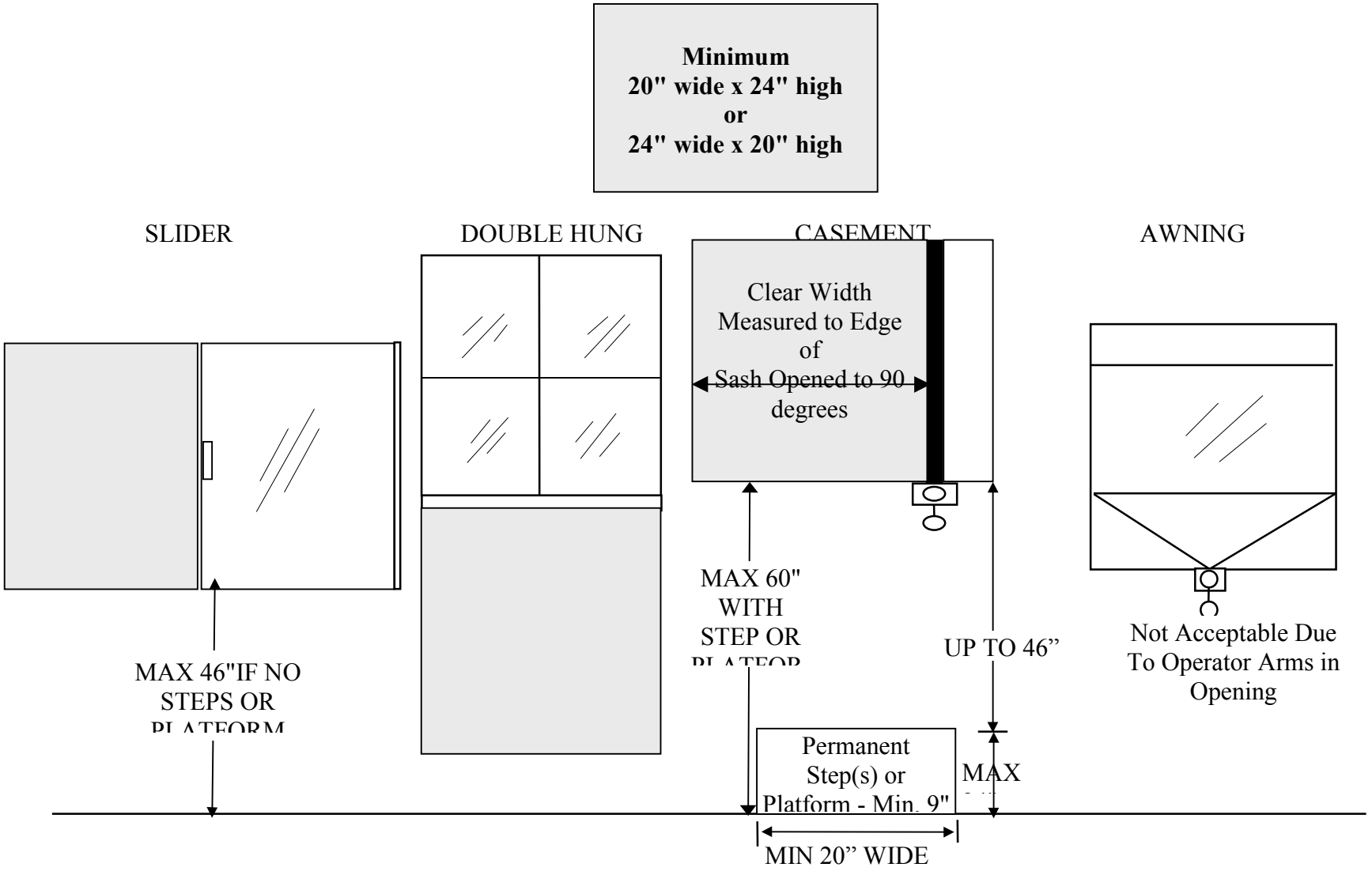
5. Ladders or other steps used to comply with subd. 4. may infringe on the required area of the areaway by a maximum of 6 inches.

6. The areaway shall be constructed such that water entering the areaway does not enter the dwelling.

Question: *Are there State-approved manufactured areaways that meet the UDC code requirements or are equivalent?*

Answer: *Yes, to date, two manufacturers have applied for and been granted approvals for egress window areaways that meet the intent of the code. Some of these have "ledges or stepped terraces" that do not meet Comm 21.04 for stairs, but act as an aid to exiting. They have been granted even when the wall furthest away from the house (which may have stepped ledges in it) do not measure 36" out from the house.*

Comm 21.03 (6)
Egress Window Dimensions



Exit Windows
See following diagram.

(7) DOORS USED FOR EXITING. Doors used for exiting shall comply with the following requirements:

(a) One of the exit doors from a dwelling unit shall be a swing-type door at least 36 inches wide by 80 inches high.

(b) 1. Except as allowed under subd. 2., all other required exit doors shall be at least 32 inches wide by 76 inches high.

2. Sliding patio doors used as a required exit shall have a clear opening of at least 30 inches.

(c) Where double doors are used as a required exit, each door leaf shall be at least 30 inches wide and the doors may not have an intermediate mullion.

(d) All exit doors shall be openable from the interior without the use of a key.

Minimum Door Width

Question: *When these sections refer to a minimum door width of 2'-8", how is to be measured.*
Answer: *The door itself should be measured - not the distance between jambs or stops.*

(8) INTERIOR CIRCULATION. All doors or openings to the following areas shall be at least 80 inches high and either provide a minimum net clear opening width of 30 inches or be a 32-inch door:

(a) At least 50% of the bedrooms.

(b) All common use areas including kitchens, dining rooms, living rooms, family rooms, basements and garages.

(c) At least one full bathroom, including doors or openings to the sink, toilet and tub or shower.

Interior Circulation - Accessibility

Question: *Can a "half-bath" with a 2'-8" door be considered accessible to disabled persons.*
Answer: *No. The code is clear in requiring one full bathroom be provided with a 2'-8" wide door. A full bathroom would contain a lavatory, water closet and bathtub or shower.*

Question: *What use is an "accessible" bathroom or bedroom with a 2'-8" door when it is on the second floor?*

Answer: *The intent of this section is to minimize future structural door framing alterations necessary to make a dwelling accessible to a physically handicapped resident. Obviously, further alterations would be necessary for the second floor situation, such as a stairway chair-lift or platform lift. Also, there may be temporary situations where a handicapped resident or guest, with physical assistance, could still make use of these second story rooms. "Accessible" does not always mean wheelchair accessible.*

Question: *Can a 2'-6" flush opening pocket door be considered accessible?*
Answer: *This section requires, where cased or uncased openings are provided in lieu of doors, the clear width of passageway openings shall be at least 2'-6" wide. Where a pocket door is installed into a cased opening, the 2'-6" width requirement still applies. In this situation, the pocket door could* ***not*** *be provided with any doorstops and must open at least flush with the cased opening so that neither the door or trim infringe upon the cased opening width.*

The intent of this code section is to provide a minimum 2'-6" width for disabled person use. Alternatively, a 2'-8" wide opening is required when swing doors are installed because of the door stops and door itself infringe on the opening width such that the effective opening is 2'-6".

Question: *Are interior doors required to separate rooms such as bedrooms or bathrooms from the rest of the dwelling?*
Answer: *No, although it is common practice to have door separating these areas, doors are not required. The minimum opening requirements in Comm 21.03 (8) must be met but doors or privacy hardware is not a code requirement.*

(9) HALLWAYS. Hallways shall be at least 3 feet in width except that door hardware, finish trim and heating registers may infringe upon this dimension.

(10) BALCONIES. (a) Balconies shall be made of concrete, metal or wood which is treated, protected or naturally decay-resistive in accordance with s. Comm 21.10.

(b) Balconies shall be provided with guardrails in accordance with s. Comm 21.04 (3).

(c) Balconies which are required for exit purposes shall also comply with all of the following requirements:

1. The balcony guardrail shall terminate no more than 46 inches above the floor level of the balcony.

2. The floor level of the balcony shall be no more than 15 feet above the grade below.

3. The floor of the balcony shall have minimum dimensions of 3 feet by 3 feet. The guardrail and its supports may infringe on the dimensions of the required area.

Balconies

*Balconies **not** used for a required exit purposes may be greater than 15 feet above grade. Guardrails for balconies are required to comply with Comm 21.04(3) regarding height, in-fill or spindle and rail spacing requirements.*

(11) SPLIT LEVEL DWELLINGS. In determining the exit requirement in a split level dwelling, all levels that are to be considered a single story shall be within 5 feet of each other.

Split Level Dwellings

This section allows floor levels within 5 feet vertically of each other to be considered one floor level for exiting purposes. This does not change the definitions of the floor levels as set forth in s. Comm 20.07. Also the requirements of ss. Comm 21.03(1), 21.03(5)(b), and 21.03(6)(b) for proper separation of exits apply to the combined areas of the floor levels..

*Also, any combined floor levels must all be within 5 feet of each other. In other words, a floor level that is between two other floor levels, separated by more than 5 feet, does not make all three levels into one even if exiting is from the middle level. However, the middle level may be combined with **only one** of the other levels.*

(12) TWO-FAMILY DWELLINGS. In a 2-family dwelling, each dwelling unit shall be provided with exits in compliance with this section.

Comm 21.04 Stairways and elevated areas.

(1) SCOPE. Every interior and exterior stairway, including tub access steps but excluding non-required basement stairways which lead directly to the building exterior and stairways leading to attics or crawl spaces, shall conform to the requirements of this section.

Non-required Stairs

Although stairways to attics and crawlspaces are not covered by the code, other non-required stairs, such as a second stairway from the first floor to a basement, are covered. Stairways are a major location of deaths and serious injuries in the home. Statistics from the U.S. Consumer Product Safety Commission (CPSC) show that one in four people will be injured and seek hospital treatment due to an injury related to stairways sometime in their lives. In 1994, the number of injuries from stairs, ramps, landings and floors was 1,879,029. This was an increase over the previous year by 11 percent (200,000-plus injuries), and was roughly equivalent to 19 percent of the total number of injuries reported in all categories for that same year.

The CPSC also estimates that the cost of home injuries in 1994 was $94.3 billion. The cost directly related to injuries from stairs, ramps, landing and floors was $17.5 billion.

Similarly, a study prepared for the U.S. National Bureau of Standards estimated that stair riser/tread dimensions are factors in nearly 50 percent of all stair-related injuries in the home.

Exterior Stairs

***Question**: This section applies to exterior stairs but how far away from the dwelling would this coverage extend?*

***Answer**: The stair requirements would apply to any steps necessary to get an occupant free and clear of the dwelling and to grade.*

***Question**: Do bulkhead-type doors and stairways need to be code complying?*

***Answer**: No, they must be code complying only if they are used AS AN EXIT, not if they are used as a service or non-required stairway. Verify the following item for required exits:*

- landings,
- handrails,
- stairway width,
- headroom, and
- stair treads and risers.

In the case of bulkhead-type doors and stairs:

- *The headroom height may be measured with the doors open, since the stairway is only usable if the doors are opened; and*

- *A landing is not required at the head of the stairway since this is considered an interior stairway protected from the weather. However, a landing is required at grade outside the door.*

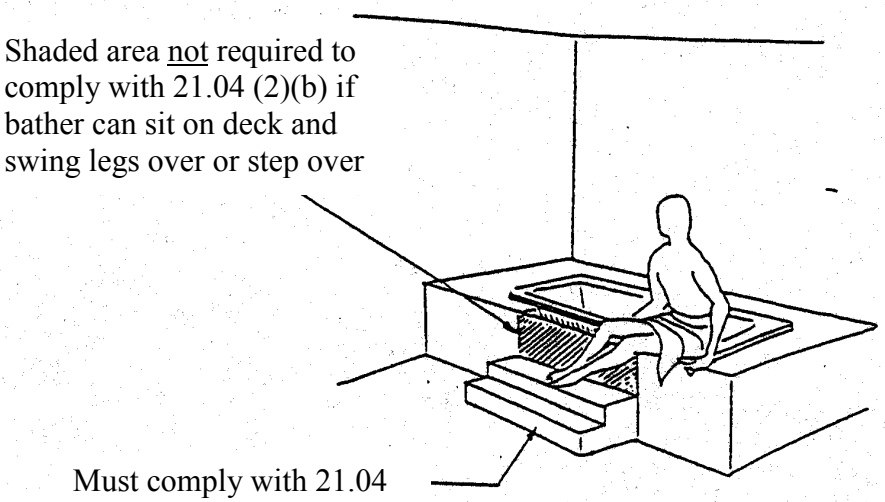
Regarding the door(s), they must meet the exit door requirements if this is a required exit. That means it must be 2'-8" wide if there is a single door and 2'-6" each if there are double doors. If this is not a required exit, then no minimum width applies. Door headroom, at the bottom of stairs, would normally have to be in compliance with the required stairway headroom.

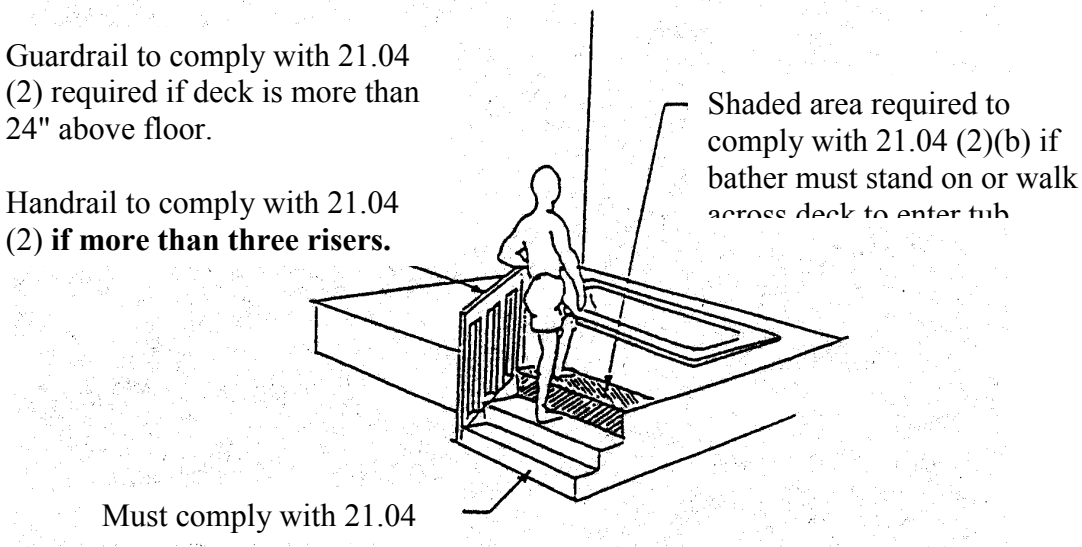
***Question**: Is a door required between the bottom of a bulkhead-type stair and the basement that it serves?*

***Answer**: This section of the code is silent on this; however, under Comm 22, most likely a door would be needed to meet the energy requirements.*

Bathtub Platforms

Question: *Do the stair code requirements apply to steps serving a bathtub platform?*
Answer: *Yes. Where a step or steps are provided at a bathtub, whirlpool or hot tub, the steps are required to have a minimum 9-inch tread and maximum 8-inch riser. Where more than one step is provided, the steps need uniform risers and treads. The rim of the tub should not be considered a step unless it is a large area where occupants are likely to walk around the tub. Steps are not required to be provided at the base of a tub, but due to damp slippery conditions associated with tubs, steps that are provided should comply with the code.*





Headroom Width and Handrail requirements of Comm 21.04. (See following diagram.)

(2) DETAILS. (a) Width. 1. Except for spiral staircases under subd. 2., stairways shall measure at least 36 inches in width. Handrails and associated trim may project a maximum of 4.5 inches into the required width at each side of the stairway.

2. Spiral staircases shall be at least 26 inches wide measured from the outer edge of the supporting column to the inner edge of the handrail.

(b) Riser height. 1. a. Except for spiral staircases under subd. 2., risers may not exceed 8 inches in height measured vertically from tread to tread.

b. At the top and bottom of a flight, measurement shall be taken from the top of the nosing to the finished floor surface unless the finished surface is carpeting, in which case measurement shall be made to the hard surface below the carpeting.

2. Risers in spiral staircases may not exceed 9.5 inches in height measured vertically from tread to tread.

(c) Tread depth. 1. 'Rectangular treads.' Rectangular treads shall have minimum tread depth of 9 inches measured horizontally from nosing to nosing.

2. 'Spiral staircase treads.' Spiral staircase treads shall have a minimum tread depth of 7 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread.

3. 'Winder treads in series.' Two or more winder treads may be placed immediately adjacent to each other anywhere in a stairway provided both of the following conditions are met:

a. The winder treads shall have a minimum tread depth of 7 inches measured at a point 12 inches from the narrow end of the tread.

b. The depth of the immediately adjoining winder treads shall be equal at a point 12 inches from the narrow end.

4. 'Individual winder treads.' a. An individual winder tread may be placed between rectangular treads or at the end of a flight of rectangular treads provided the tread depth, measured at a point 12 inches from the narrow end, is equal to the tread depth of the rectangular steps in the flight.

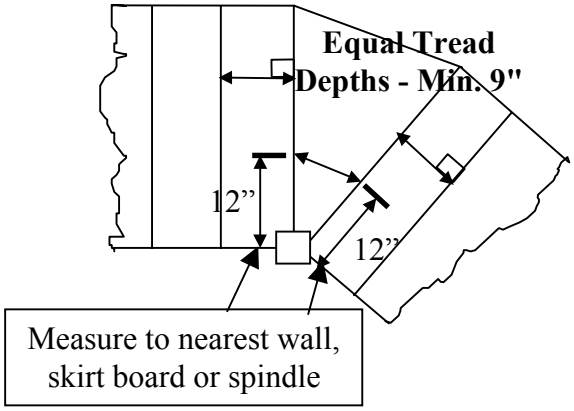
b. There may be more than one individual winder tread in a stairway or in a flight of stairs.

(d) Headroom. 1. Stairways shall be provided with a minimum headroom clearance of 76 inches measured vertically from a line parallel to the nosing of the treads to the ceiling, soffit or any overhead obstruction directly above that line.

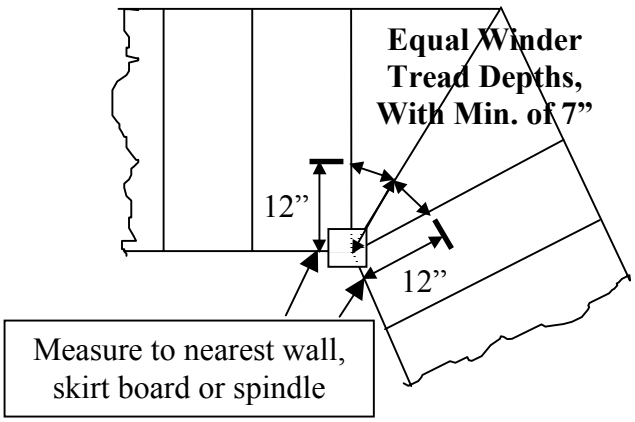
2. The headroom clearance shall be maintained over an intermediate landing.

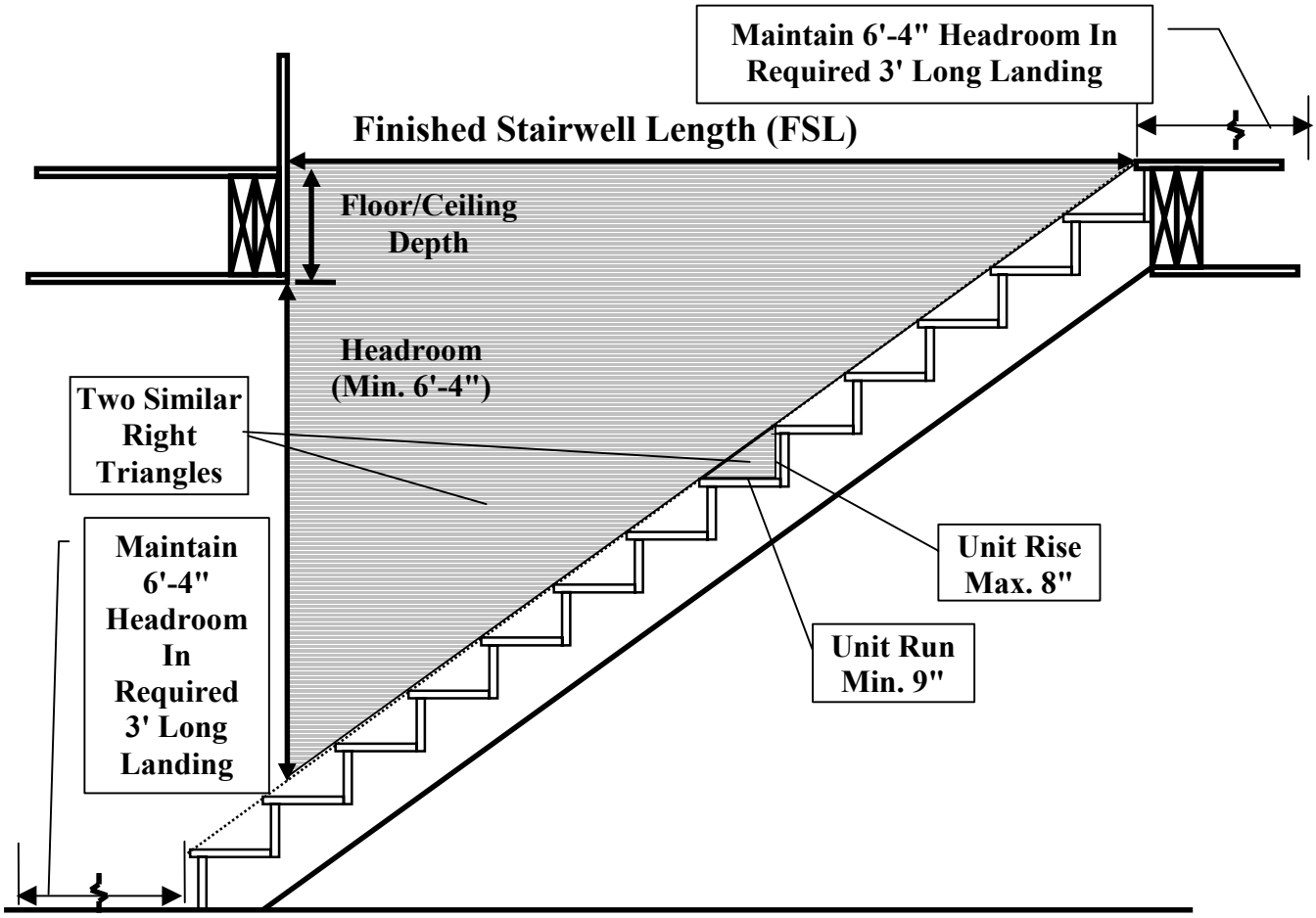
Commentary

SINGLE WINDER



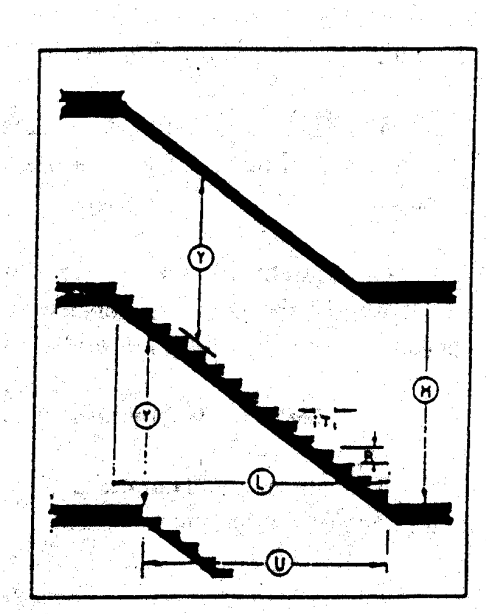
MULTIPLE WINDERS





$$\frac{\text{Headroom + Floor/Ceiling Depth (HFCD)}}{\text{Unit Rise}} \qquad \frac{\text{Finished Stairwell Length(FSL)}}{\text{Unit Run}}$$

So to solve for FSL, FSL = Unit Run x HFCD
Unit Rise



Straight Stairs

Samples and least costly requires a long hallway which may sometimes be a disadvantage.
May have walls on both sides (closed string) or may have open balustrade on one side (open string).

Height Floor to Floor M	Number of Risers	Height of Risers R	Width of Treads T	Total Run L	Minimum Headroom Y	Well Opening U
8'0"	12 13 13	8" 7 3/8" + 7 3/8" +	9" 9 1/2" 10"	8'-3" 9'-6" 10'-0"	6'-4" 6'-4" 6'-4"	8'-1" 9'-2 1/2" 9'-8 1/2"
8'6"	13 14 14	7 7/8" – 7 5/16" – 7 5/16" -	9" 9 1/2" 10"	9'-0" 10'-3 1/2" 10'-10"	6'-4" 6'-4" 6'-4"	8'-3" 9'-4" 9'-10"
9'0"	14 15 15	7 11/16" – 7 3/16"	9" 9 1/2" 10"	9'-9" 11'-1" 11'-8"	6'-4" 6'-4" 6'-4"	8'-5" 9'-6 1/2" 9'-11

3. The headroom clearance shall be maintained over a landing that is at the top or bottom of a stairway for a minimum distance of 36 inches in the direction of travel of the stairway.

(e) Uniformity. 1. Within a stairway flight, tread depths and riser heights may vary by a maximum of 3/16 inch.

2. The allowed variation in uniformity under subd. 1. may not be used to exceed the maximum riser height under par. (b) or to decrease the minimum tread depth under par. (c).

(f) Open risers. Stairways with open risers shall be constructed to prevent the through-passage of a sphere with a diameter of 6 inches or larger between any 2 adjacent treads.

(3) HANDRAILS AND GUARDRAILS. (a) General. 1. Stair flights with more than 3 risers shall be provided with at least one handrail for the full length of the stair flight.

2. Handrails or guardrails shall be provided on all open sides of stair flights consisting of more than 3 risers and on all open sides of areas that are elevated more than 24 inches above the floor or exterior grade.

3. Handrails and guardrails shall be constructed to prevent the through passage of a sphere with a diameter of 6 inches or larger.

4. Handrails and guardrails shall be designed and constructed to withstand a 200 pound load applied in any direction.

5. Exterior handrails and guardrails shall be constructed of metal, decay resistant or pressure treated wood, or shall be protected from the weather.

(b) Handrails. 1. Height. Handrails shall be located at least 30 inches, but no more than 38 inches above the nosing of the treads. Measurements shall be taken from the hard structural surface beneath any finish material to the top of the rail. Variations in uniformity are allowed only when a rail contacts a wall or newel post or where a turnout or volute is provided at the bottom steps.

2. Clearance. The clearance between a handrail and the wall surface shall be at least 1 1/2 inches.

3. Winders. a. Except as provided under subd.3. b., the required handrail on winder steps shall be placed on the side where the treads are wider.

b. Where all winder steps in a flight have a tread depth of at least 9 inches from nosing to nosing measured at a point 12 inches from the narrow end of the tread, the required handrail may be located on either side of the stairway.

4. Projection. Handrails and associated trim may project into the required width of stairs and landings a maximum of 4 1/2 inches on each side.

5. Size and configuration. Handrails shall be symmetrical about the vertical centerline to allow for equal wraparound of the thumb and fingers.

a. Handrails with a round or truncated round cross sectional gripping surface shall have a maximum whole diameter of 2 inches.

b. Handrails with a rectangular cross sectional gripping surface shall have a maximum perimeter of 6 1/4 inches with a maximum cross sectional dimension of 2 7/8 inches.

c. Handrails with other cross sections shall have a maximum cross sectional dimension of the gripping surface of 2 7/8 inches with a maximum linear gripping surface measurement of 6 1/4 inches and a minimum linear gripping surface of 4 inches.

Note: See appendix for further information on handrail measurement.

6. Continuity. Handrails shall be continuous for the entire length of the stairs except in any one of the following cases:

a. A handrail may be discontinuous at an intermediate landing.

b. A handrail may have newel posts.

c. A handrail may terminate at an intermediate wall provided the lower end of the upper rail is returned to the wall or provided with a flared end, the horizontal offset between the two rails is no more than 12 inches measured from the center of the rails, and both the upper and lower rails can be reached from the same tread without taking a step.

(c) Guardrails. 1. Application. All openings between floors, and open sides of landings, platforms, balconies or porches that are more than 24 inches above grade or a floor shall be protected with guardrails.

2. Height. Guardrails shall be located at least 36 inches above the floor. Measurement shall be taken from the hard structural surface beneath any finished material to the top of the rail.

3. Opening size. Guardrails shall be constructed to prevent the through-passage of a sphere with a diameter of 6 inches or larger.

Handrails or Guardrails

See handrail digrams in the Appendix.

Question: *At the time of occupancy, a sliding patio door installed in an exterior wall is viewed by the inspector without an exterior deck,landing, stairway or platform. The floor to grade elevation difference is greater then 8 inches. Is this okay since two other exit doors could provide exiting from the dwelling and the elevation difference is less than 24 inches?*

Answer: *No. The presence of the door, whether required or not, is installed to allow exiting and movement between areas. There is an elevation difference from the floor to grade in the exit path so a stairway or landing platform is required per s. Comm 21.04 prior to occupancy. However, if the door was substantially fastened closed with hardware and screws that would not allow it to be opened*

more then 6", then it could be considered glazing and steps would not be required in the interim until a proper exit path is provided.

Question: *Does a none required guardrail serving a porch less than 24 inches above grade need to comply with the code?*

Answer: *This section does not require the guardrail where the porch is less than 24 inches above exterior grade; therefore the height and other specifications are* ***not*** *required for the guardrail installed. Section Comm 21.04 (Introduction) does require all stairways to conform to the requirements of s. Comm 21.04.*

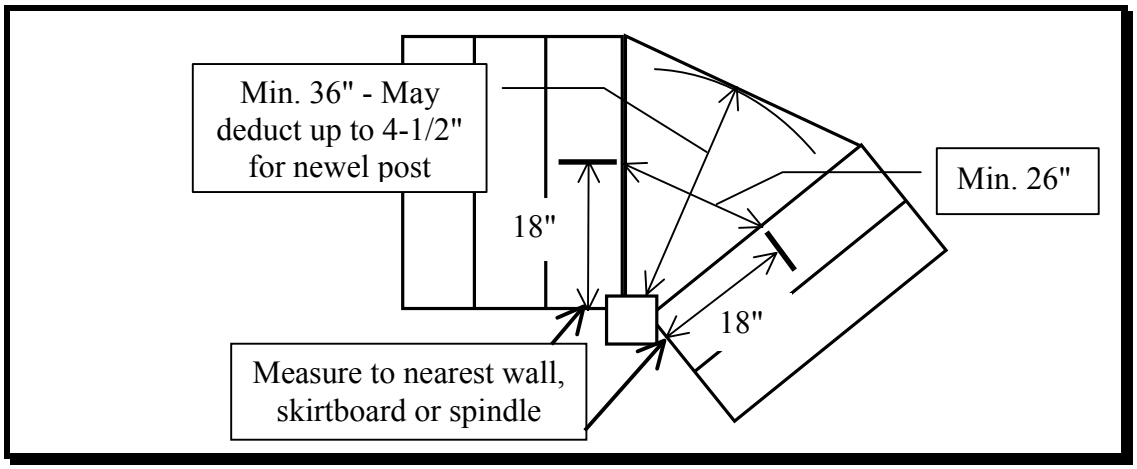
The designer may still want to install the guardrail per code to alleviate concerns that the installation of a none required guardrail meeting less than the minimum specifications may provide a false sense of safety for the building occupants.

(4) LANDINGS. (a) Intermediate landings. 1. A level intermediate landing shall be provided for any stairway with a height of 12 feet or more.

2. Intermediate landings that connect 2 or more straight flights of stairs, or 2 flights of stairs at a right angle, shall be at least as wide as the stairs and shall measure at least 36 inches in the direction of travel.

3. Curved or irregular landings shall have a radius of at least 36 inches.

4. Curved or irregular landings shall have a minimum straight line measurement of 26 inches between the nosing of the 2 connecting treads measured at a point 18 inches from the narrow end of the landing measured along the nosing of the 2 treads.



(b) Landings at the top and base of stairs. A level landing shall be provided at the top and base of every stairs. The landing shall be at least as wide as the stairs and shall measure at least 3 feet in the direction of travel.

(c) Doors at landings. 1. Except as provided in subd. 1. a. to c., level landings shall be provided on each side of any door located at the top or base of a stairs, regardless of the direction of swing. In the following exceptions, stairways to attached garages or porches are considered interior stairs:

a. A landing is not required between the door and the top of interior stairs if the door does not swing over the stairs.

b. A landing is not required between the door and the top of an interior stairs of 1 or 2 risers regardless of the direction of swing.

c. A landing is not required between a sliding glass door and the top of an exterior stairway of 3 or fewer risers.

2. The exterior landing, platform or sidewalk at an exterior doorway shall be located a maximum of 8 inches below the interior floor elevation and shall have a length of at least 36 inches in the direction of travel out of the dwelling.

Projections into Landings

The 4 1/2-inch maximum allowed projection of handrails or trim into the width of a stairway on each side also applies to both sides of a landing since the landing is part of the stairway.

Interior Sliding Glass Doors

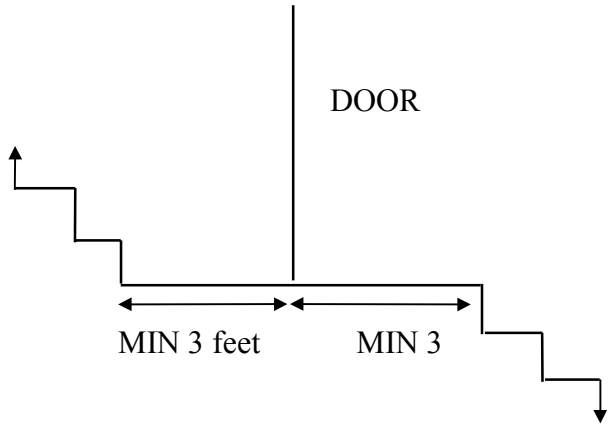
***Question**: Is a landing required at a stairway leading to a sliding door?*

***Answer**: No, if this is an interior door. Exception a., which applies here, eliminates the landing if the door does not swing over the stairs. Obviously, a sliding door could not swing over the steps. This exception applies to both opaque and glazed doors.*

Yes and no if this is an exterior door. Exception c., eliminates the landing if there are no more than three risers. This exception only applies if the door is a sliding glass door. Otherwise, a landing is always required per the introductory paragraph.

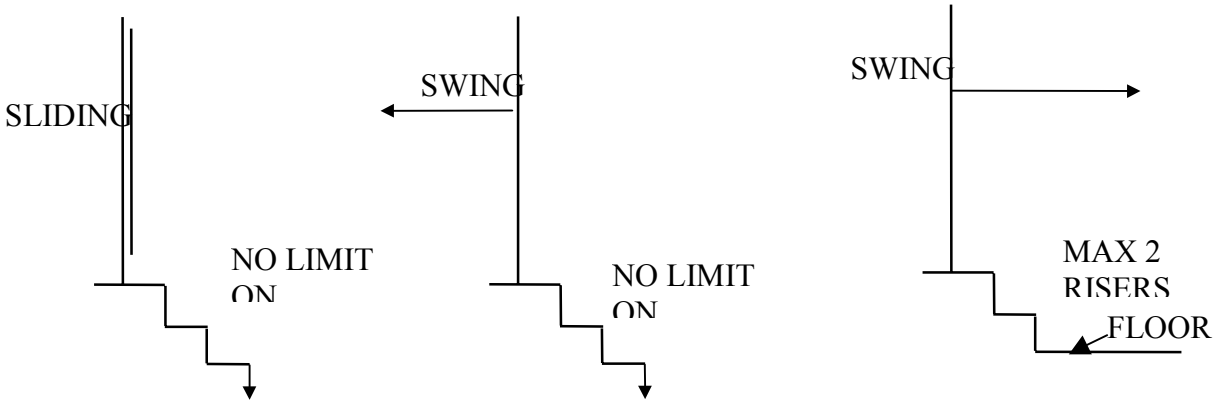
***Question**: Is a landing required at an exterior patio (french door) glazed swinging door?*

***Answer**: If the exterior grade elevation is more than 8 inches lower than the interior floor elevation, a landing is required. The sliding glass door exception does not apply to swing exterior glass doors regardless if they swing in or out of the dwelling.. The argument of the door being glazed permitting occupants to see a elevation change or step conditions on the other side of the door does not hold true due to drapes or other visual obstructions frequently being provided on the door.*

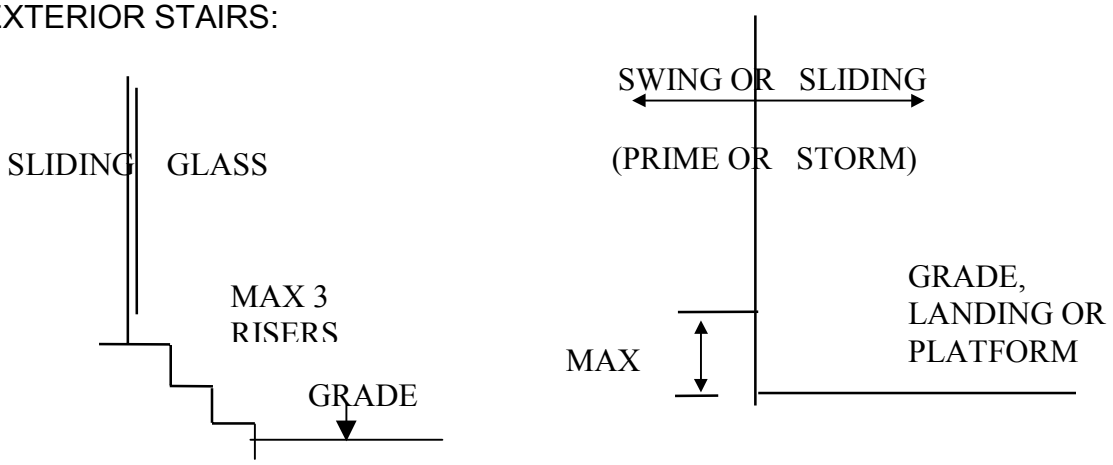


EXCEPTIONS:

INTERIOR STAIRS: (GARAGES AND (protected) PORCHES ARE INTERIOR SPACES)



EXTERIOR STAIRS:



Tread and Riser Uniformity

Tread and riser uniformity must be maintained in any flight of stairs. Once an intermediate landing occurs, a new flight starts and new riser and tread dimensions may be used.

***Question**: How is tread and riser measured for the purposes of this requirement, especially taking into account the variety of finish materials used?*

***Answer**: The tread and risers should be measured prior to application of carpeting. Measurements should be taken to hard surface finish materials. This alleviates problems encountered when the homeowner changes carpeting materials. If the carpeting is already in place, the inspector should estimate the thickness of carpeting and padding to determine compliance. The inspector should walk up and down the stairs, as well, to determine what, if any, tripping or falling hazard exists.*

***Question**: At an exterior door (or an interior door, such as the 20-minute rated door, between the house and garage) a threshold separates the main floor level from the stair or landing, either up or down. Is the height of the threshold included in the riser height when you are determining if all risers are uniform?*

***Answer**: No, you always measure from hard surface to hard surface. This means from the floor level to the landing or tread, even if the threshold **"could"** be stepped on, it **is not** included in the height of the riser. Remember that carpeting is not a hard surface even if is indoor/outdoor type material.*

Comm 21.042 Ladders.

Ladders which are used as part of a required exit shall conform to this section.

(1) DESIGN LOAD. Ladders shall be designed to withstand loads of at least 200 pounds.

(2) Tread or rungs. (a) Minimum tread requirements shall be specified in Table 21.042. Treads less than 9 inches in width shall have open risers. All treads shall be uniform in dimension.

TABLE 21.042

Pitch of Ladder Angle to Horizontal (degrees)	Maximum Rise (inches)	Minimum Tread (inches)
41.6 to 48.4	8	9
greater than 48.4 to 55.0	9	8
greater than 55.0 to 61.4	10	7
greater than 61.4 to 67.4	11	6
greater than 67.4 to 71.6	12	5
greater than 71.6 to 75.9	12	4
greater than 75.9 to 80.5	12	3
greater than 80.5 to 90	12	2

(b) Rungs may only be used for ladders with a pitch range of 75° to 90°. Rungs shall be at least 1 inch in diameter for metal ladders and 1 1/2 inches for wood ladders. All rungs shall be uniform in dimension.

Ladder Treads

Ladder treads are measured the same as stairway treads - horizontally from nosing to nosing.

(3) RISERS. Risers shall be uniform in height and shall conform with Table 21.042.

(4) WIDTH. The width of the ladder shall be a minimum of 20 inches wide and a maximum of 30 inches wide.

(5) HANDRAILS. (a) Handrails shall be required for ladders with pitches less than 65°.

(b) Handrails shall be located at least 30 inches, but not more than 38 inches, above the nosing of the treads.

(c) Open handrails shall be provided with intermediate rails or an ornamental pattern such that a sphere with a diameter or 6 inches or larger cannot pass through.

(d) The clearance between the handrail and the wall surface shall be at least 1 1/2 inches.

(e) Handrails shall be designed and constructed to withstand a 200-pound load applied in any direction.

(6) CLEARANCES. (a) The ladder shall have a minimum clearance of at least 15 inches on either side of the center of the tread.

(b) The edge of the tread nearest to the wall behind the ladder shall be separated from the wall by at least 7 inches.

Top Ladder Tread

This code section is requiring that the top tread's (first tread below the floor level) back edge be at least 7 inches from the wall in front of it. This ensures adequate footroom and still allows a full depth tread.

(c) A passage way clearance of at least 30 inches parallel to the slope of a 90° ladder shall be provided. A passage way clearance of at least 36 inches parallel to the slope of a 75° ladder shall be provided. Clearances for intermediate pitches shall vary between these 2 limits in proportion to the slope.

(d) For ladders with less than a 75° pitch, the vertical clearance above any tread or rung to an overhead obstruction shall be at least 6 feet 4 inches measured from the leading edge of the tread or rung.

Comm 21.045 Ramps.

Every exterior or interior ramp which leads to or from a required exit shall comply with the requirements of this section.

(1) SLOPE. Ramps shall not have a gradient greater than 1 in 8 or one foot of rise in 8 feet of run. Walkways with gradients less than 1 in 20 or one foot of rise in 20 feet of run are not considered to be ramps.

(2) SURFACE AND WIDTH. Ramps shall have a slip resistant surface and shall have a minimum width of 36 inches measured between handrails.

(3) HANDRAILS. Handrails shall be provided on all open sides of ramps. Every ramp that overcomes a change in elevation of more than 8 inches shall be provided with at least one handrail.

(a) Ramps which have a gradient greater than 8.33% or 1:12 or one foot rise in 12 feet of run and which overcome a change in elevation of more than 24 inches shall be provided with handrails on both sides.

(b) Handrails shall be mounted so that the top of the handrail is located between 30 to 34 inches above the ramp surface.

(c) Open-sided ramps shall have the area below the handrail protected by intermediate rails or an ornamental pattern to prevent the passage of a sphere with a diameter of 6 inches or larger.

(d) The clear space between the handrail and any adjoining wall shall be at least 1-1/2 inches.

(4) LANDINGS. A level landing shall be provided at the top, at the foot and at any change in direction of the ramp. The landing shall be at least as wide as the ramp and shall measure at least 3 feet in the direction of travel.

Comm 21.05 Light and ventilation.

(1) NATURAL LIGHT. All habitable rooms shall be provided with natural light by means of glazed openings. The area of the glazed openings shall be at least 8% of the net floor area, except under the following circumstances:

(a) Exception. Habitable rooms, other than bedrooms, located in basements or ground floors do not require natural light.

(b) Exception. Natural light may be obtained from adjoining areas through glazed openings, louvers or other approved methods. Door openings into adjoining areas may not be used to satisfy this requirement.

(2) VENTILATION. (a) Natural ventilation. Natural ventilation shall be provided to all habitable rooms by means of openable doors, skylights or windows. The net area of the openable doors, skylights or windows shall be at least 3.5% of the net floor area of the room. Balanced mechanical ventilation may be provided in lieu of openable exterior doors, skylights or windows provided the system is capable of providing at least one air change per hour of fresh outside air while the room is occupied. Infiltration may not be considered as make-up air for balancing purposes.

(b) Exhaust ventilation. All exhaust ventilation shall terminate outside the building.

Light and Ventilation

Question: *Can an exhaust vent duct terminate in the attic, crawlspace, garage or into the roof soffit.*

Answer: *No. This code section requires that all exhaust duct shall terminate OUTSIDE the "building" or "structure." Therefore, the exhaust system may not terminate in the attic, crawlspace, garage or within the soffit portion of the attic. The soffit material on either side of the exhaust discharge grill should be solid for at least 2' on either side of the grill so that exhaust is not directed back into the attic space. However, exhaust ducts are not prevented from passing through these areas as long as the duct termination passes through or is tight fitted to the exterior "skin" of the building to ensure the air is exhausted outside. Simply pointing an exhaust duct in the direction of a soffit vent or other vent opening is not acceptable. This issue is similarly regulated by s. Comm 23.02(3)*

(3) ATTIC VENTILATION. Ventilation above the ceiling or attic insulation shall be provided as specified in s. Comm 22.08 (1).

(4) CRAWLSPACE VENTILATION. (a) General. Unheated crawlspaces shall be ventilated in accordance with either s. Comm 22.08 (2).

(b) Vapor retarder. 1. Crawlspaces shall be provided with a vapor retarder that has a transmission rate of 0.1 perm or less.

2. All decayable organic material, including topsoil, shall be removed from crawlspace floors prior to placing the vapor retarder.

Attic and Crawlspace Ventilation

Also see s. Comm 22.08 of the code and this commentary for additional requirements and information.

(5) SAFETY GLASS. Except as provided in par. (e), glazing shall consist of safety glass meeting the requirements of ANSI Z 97.1 when installed in any of the following locations:

(a) In any sidelight adjacent to a door where the nearest point is within 2 feet of the door.

(b) In a wall that comprises part of a tub or shower enclosure where the glazing is within 5 feet vertically of the lowest drain inlet and within 3 feet horizontally of the nearest part of the inner rim of the tub.

(c) Within 4 feet vertically of a tread or landing in a stairway and within one foot horizontally of the near edge of the tread or landing.

(d) Within 4 feet vertically of the floor and 3 feet horizontally of the nosing of the top or bottom tread of a stair.

(e) Safety glass is not required where the size of an individual pane of glass is 8 inches or less in the least dimension.

Note: The U.S. Consumer Product Safety Commission requires safety glass for glazing in internal and external doors, including storm door and patio doors, as well as for the tub or shower enclosures themselves. These federal rules, contained in 16 CFR, subchapter B, part 1201, apply in addition to any state rules or statutes.

Safety Glass

This code section is very brief and needs some elaboration. It is important to note that state statutes s. 101.125 also requires safety glazing. In addition, the Federal Consumer Product Safety Commission (CPSC) in its regulation 16 CFR Part 1201 sets a minimum for safety glazing requirements that states may only exceed with their requirements. While local inspectors are not responsible for enforcing state statutory or CPSC's requirements, we are including them to clarify the UDC requirements and to inform contractors of their total obligations. Also, while most of the items covered by these requirements are glazed in the factory, local inspectors may become involved when site-made doors are used, re-glazing is done, old doors are reused, sidelights are site-installed or when the manufacturer fails in its obligations. Following are some questions and answers on these various requirements.

***Question**: Why is safety glazing necessary?*
***Answer**: The CPSC found that prior to its rules in 1974 that approximately 73,000 injuries related to architectural glazing were treated annually in hospitals nationwide. Almost half were under age 14. The worst accidents are those where the victim breaks the glass on impact and then he or she rebounds back. On the rebound, the shards of glass get caught under the skin and then severely rip it as the victim continues rebounding.*

Question: *What is and isn't acceptable as safety glazing?*

Answer: *Acceptable:*

- *<u>Tempered glass</u> is acceptable. It is produced by reheating glass and then suddenly cooling it. It is four times stronger than regular annealed glass. It cannot be cut after tempering so dealers will often need to custom order it from a tempering facility. It breaks into small pieces when broken.*

- *<u>Laminated glass</u> is acceptable. It consists of two or more layers of glass bonded to a tough resin interlayer. It can be cut or drilled.*

Tempered glass and laminated glass is classified by the manufacturer as either Category I for use only in doors where the glazing is less than 9 square feet or Category II for all other uses.

Not Acceptable:

- *Wired glass is not acceptable by the CPSC except when used in a code-required fire separation as in s. 21.08 of this commentary. However, the State Statutes would allow it anywhere.*

- *Heat-strengthened glass is not acceptable. It is produced similarly to tempered glass but is cooled slower. As a result, it is only twice as strong as regular annealed glass. It can be cut or drilled.*

- *Annealed glass is not acceptable. It is regular glass that may also be known as flat or primary glass. Also not acceptable are plate, float, sheet and patterned glass. These are easily cut and drilled.*

<u>Plastic glazing</u> is not considered glass so it is not subject to the safety glazing requirements.

When safety glazing is required, all layers of a multi-layer assembly (e.g., insulated glass) must be safety glazed.

Question: *Is safety glazing required in glazed panels on both sides of a sliding patio door which has one fixed and one operating panel?*

Answer: *Yes, the CPSC requires both panels of a patio door to be safety glazed, whether they are fixed or operating. Therefore the Wisconsin code requirement applies to glazed panels on either side.*

Question: *Are these requirements retroactive?*

Answer: *While the UDC only applies to one- and two-family dwellings built since June 1, 1980, both the CPSC and state statutory requirements are retroactive to any reglazing work done in all types and ages of structures.*

Question: *How can I identify safety glass?*
Answer: *It will normally have a permanent label in the corner.*

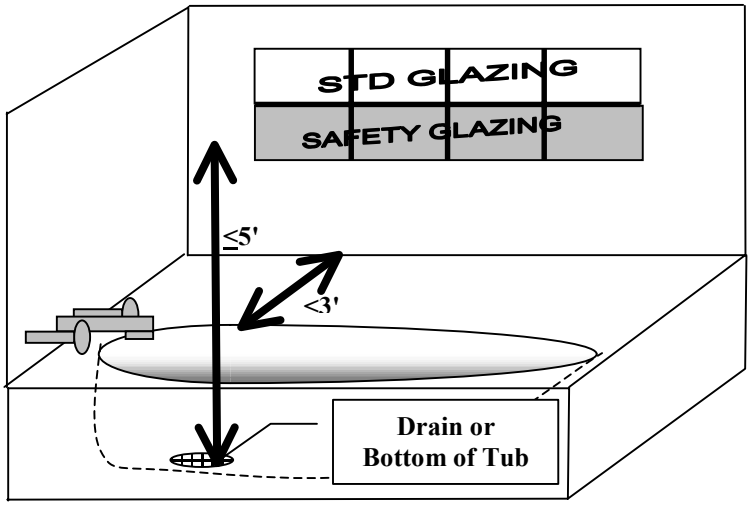
Question: *Can leaded stained glass be used where safety glass is required?*
Answer: *Yes, based on the state statutes and CPSC regulations, this would be acceptable.*

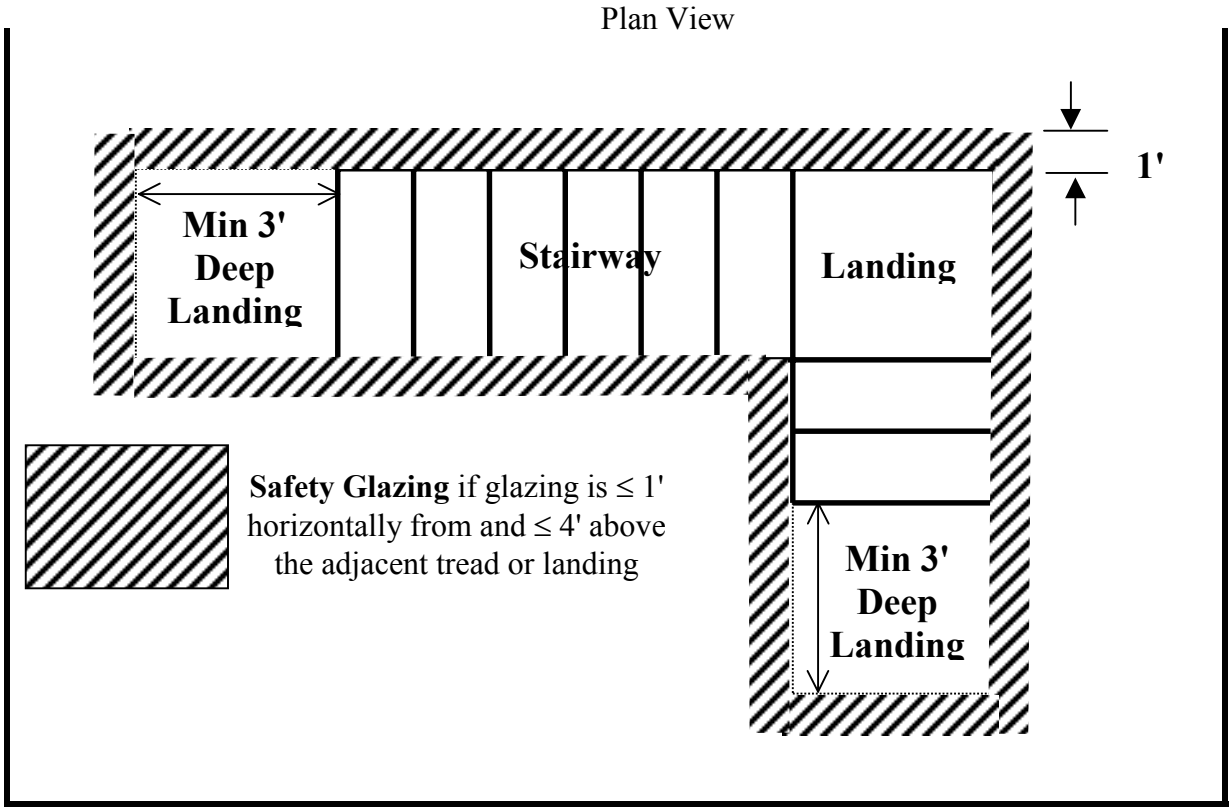
Question: *Does the UDC require safety glass in panels or windows that come down near the floor but not next to a door?*
Answer: *No, although the Commercial Building Code, various model codes and good design would require safety glass in such situations, the UDC does not.*

Question: *Is safety glass required in garage vehicle doors?*
Answer: *No. The safety glazing requirement is for doors that are primarily used for human passage.*

Question: *Is safety glass required in skylights?*
Answer: *Not by the UDC or CPSC, although the Commercial Building Code and various model codes require its use in skylights. However, the 20 or 40 PSF snow load requirement of the UDC must be met. Similarly, the 200-pound loading requirement must be met for guardrails and handrails with glass infill sections.*

Question: *Are glass blocks or glass block windows used in a tub or shower area in compliance with the safety glazing rules?*
Answer: *Yes, first the individual units normally don't exceed the minimum dimensional requirements for safety glazed units. Secondly, the process used in the manufacturing of glass block puts them into the category of a masonry unit and therefore they do not need to meet the requirements for safety glazing.*





Comm 21.06 Ceiling height.

All habitable rooms, kitchens, hallways, bathrooms and corridors shall have a ceiling height of at least 7 feet. Habitable rooms may have ceiling heights of less than 7 feet provided at least 50% of the room's floor area has a ceiling height of at least 7 feet. Beams and girders or other projections shall not project more than 8 inches below the required ceiling height.

Ceiling Height

Question: *Does a basement have to comply with the 7-foot minimum ceiling height requirement?*

Answer: *It only does in those 'habitable' areas of the basement that contain rooms used for sleeping, living, dining, kitchens, hallways, bathrooms and corridors. From a practical standpoint, most basements will contain some of these uses initially or after the basement is finished-off in the future. Some foresight by the builder/owner is required, since changing ceiling height is not a practical building alteration.*

Question: *May a ceiling fan or light fixture encroach on the required ceiling height?*

Answer: *A ceiling fan or light fixture may encroach similar to a beam or ductwork - no more than 8 inches below the required ceiling height; therefore, 6'-4" minimum clearance maintained between fan or other obstruction and the floor.*

Comm 21.07 Attic and crawlspace access.

(1) ATTIC. Attics with 150 or more square feet of area and 30 or more inches of clear height between the top of the ceiling framing and the bottom of the rafter or top truss chord framing shall be provided with an access opening of at least 14 by 24 inches, accessible from inside the structure.

Question: *Can access be provided from outside the building such as an outside vent or scuttle?*

Answer: *Yes, however, any area of 150 square feet or more must still comply with the minimum opening size of 14" x 24". This means if you have a home with more than one attic space separated by a cathedral ceiling, two openings would be needed.*

(2) CRAWLSPACES. Crawlspaces with 18 inches of clearance or more between the crawlspace floor and the underside of the house floor joist framing shall be provided with an access opening of at least 14 by 24 inches.

Question: *Do crawlspaces built with less than 18 inches of clearance or over concrete slabs need access?*

Answer: *No access required; however, if area is outside the dwelling thermal envelope, venting is required.*

Note: Access to plumbing or electrical systems may be required under chs. Comm 81-86, Plumbing Code or ch. Comm 16, Electrical Code, Volume 2.

Definition of Crawlspace

The requirements of crawlspace ventilation and floor covering per ss. Comm 21.05(4) and 22.08(2) and 22.22(5) would apply to all under-floor spaces outside the thermal envelope.

Comm 21.08 Fire separation and dwelling unit separation.

(1) FIRE SEPARATION. Dwelling units shall be separated from garage spaces, accessory buildings and other dwelling units in accordance with Table 21.08 and the following requirements:

TABLE 21.08

Between Dwelling And:	Distance Between Objects[1]	Fire-Rated Construction[2, 5]
Detached garage or accessory building on same property	Less than 5 feet	3/4-hour wall[3] 1/3-hour door or window[3]
Another dwelling on same property	Less than 5 feet	3/4-hour wall[4] 1/3-hour door or window[4]

Detached garage, accessory building, or other dwelling on same property	5 to 10 feet	¾-hour wall[3] No requirement on openings
Detached garage, accessory building, or other dwelling on same property	More than 10 feet	No requirements
Property Lines	Less than 3 feet	¾-hour wall 1/3-hour door or window
Property Lines	3 feet or more	No requirements

[1]Distance shall be measured perpendicular from wall to wall or property line, ignoring overhangs.
[2]Fire rated construction shall protect the dwelling from an exterior fire source.
[3]Fire rated construction may be in either facing wall.
[4]Fire rated construction shall be in both facing walls.
[5]The methods for garage separation in par. (a) 1. are examples of ¾-hour wall construction.

(a) Attached garages. 1. The walls and ceiling between an attached garage and any portion of the dwelling, including attic or soffit areas, shall be ¾ hour fire-resistive construction or shall be constructed as specified in any of the following:

a. One layer of 5/8-inch Type X gypsum drywall shall be used on the garage side of the separation wall or ceiling.

b. One layer of ½-inch gypsum drywall shall be used on each side of the separation wall or ceiling.

c. Two layers of ½-inch gypsum drywall shall be used on the garage side of the separation wall or ceiling.

2. For all methods listed under subd. 1., drywall joints shall comply with one of the following:

a. Joints shall be taped or sealed.

b. Joints shall be fitted so that the gap is no more than 1/20-inch with joints backed by either solid wood or another layer of drywall such that the joints are staggered.

Note: 1/20-inch is approximately the thickness of a U.S. dime.

3. Vertical separations between an attached garage and a dwelling shall extend from the top of a concrete or masonry foundation to the underside of the roof sheathing or fire-resistive ceiling construction.

4. Adjoining garage units are not required to be separated from each other.

(b) Structural elements exposed in an attached garage. Beams, columns and bearing walls which are exposed to the garage and which provide support for habitable portions of the dwelling shall be protected by one of the methods specified in par. (a) 1. a. or c. or other ¾ hour fire-resistive protection.

(c) Doors. The door and frame assembly between the dwelling unit and an attached garage shall be labeled by an independent testing agency as having a minimum fire-resistive rating of 20 minutes. The test to determine the 20-minute rating is not required to include the hose stream portion of the test.

Note: Acceptable tests for fire rating of door assemblies include ASTM E-152, UL 10B, and NFPA 252.

(d) Other openings. 1. Access openings in fire separation walls or ceilings shall maintain the required separation and shall have any drywall edges protected from physical damage.

2. The cover or door of the access opening shall be permanently installed with hardware that will maintain it in the closed position when not in use.

Fire Separation

Question: *It has been common practice to have a 6- to 8-inch step between a garage and the house. Is this no longer a requirement in the Uniform Dwelling Code?*

Answer: *The step requirement has **never** been a rule in the Uniform Dwelling Code. That requirement appears to be one that had been established in local ordinances. We are unable to find any national building code which has any requirement relating to a difference in elevation between a garage floor and the interior of the dwelling. Builders who are concerned with handicap accessibility are promoting same height floor levels.*

The Uniform Dwelling Code, however, does provide safety for the occupants of a dwelling with an attached garage in a number of alternate ways. The main requirement is that of a 45-minute fire separation as outlined in s. Comm 21.08. The dwelling code also requires, under s. Comm 21.08(2), that the floor of the garage slope toward the exterior. These two requirements, along with the requirement of s. Comm 21.09 requiring smoke detectors, are deemed to provide adequate protection for the occupants.

Question: *Is it acceptable for an attic access opening to be located in the fire separation wall or ceiling?*

Answer: *Yes, if the opening cover or door is constructed such that:*

- *The 45-minute rating is maintained.*

- *Any dry wall edges on both the hatch and the surrounding area exposed to physical damage are protected.*
- *The cover or door is installed so that it is permanent (none removable) with hardware to maintain it in a closed position with latching hardware to maintain it in a closed position. This could be accomplished by the use of spring loaded hinges, door closer, or hardware that will not allow it to be left in an open position when not in use. A single bolt type or hook and eye hardware does not provide a positive closure since these could allow the door to be left open. Likewise drywall screws are "fasteners" and not hardware so they can not be used as the only means of keeping access doors closed. Vertical or horizontal sliding doors must also have hardware installed that will maintain them in a closed position when not in use.*

(2) DWELLING UNIT SEPARATION. (a) General. In 2-family dwellings, dwelling units shall be separated from each other, from common use areas, from shared attics, and from exit access corridors.

(b) Doors. Any door installed in the dwelling unit separation shall have the door and frame assembly labeled by an independent testing agency as having a minimum fire-resistive rating of 20 minutes. The test to determine the 20-minute rating is not required to include the hose stream portion of the test.

(c) Walls. Walls in the dwelling unit separation shall be protected by not less than one layer of ½-inch gypsum wallboard or equivalent on each side of the wall with joints in compliance with sub. (1) (a) 2.

(d) Floors and ceilings. A fire protective membrane of one layer of 5/8-inch Type X gypsum wallboard with joints in compliance with sub. (1) (a) 2., shall be provided on the ceiling beneath the floor construction that provides the separation.

(e) Attics and concealed roof spaces. 1. Attic areas, mansards, overhangs and other concealed roof spaces shall be totally separated above and in line with the tenant separation wall.

2. Acceptable attic separation materials include:

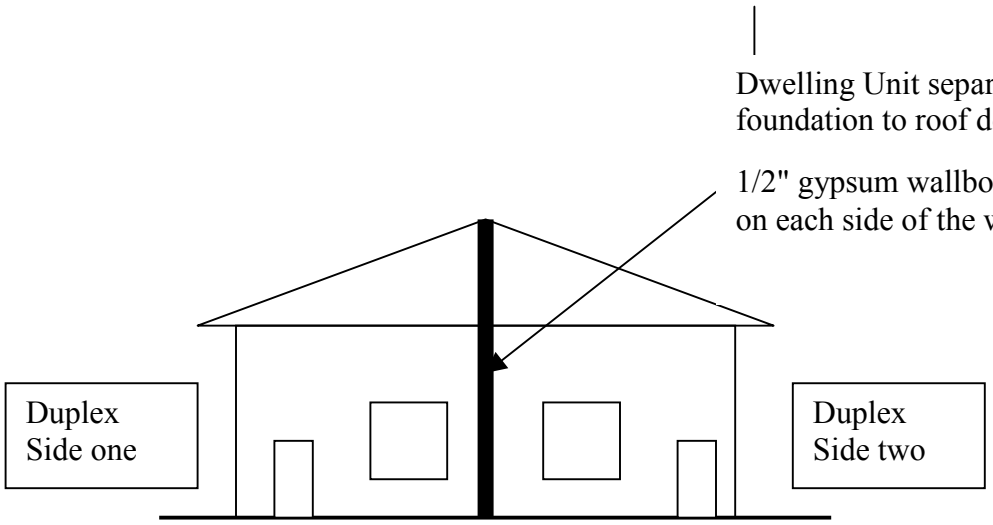
a. 2-inch nominal lumber.

b. Two layers of one-inch nominal lumber.

c. 1/2-inch nominal plywood or wood structural panel.

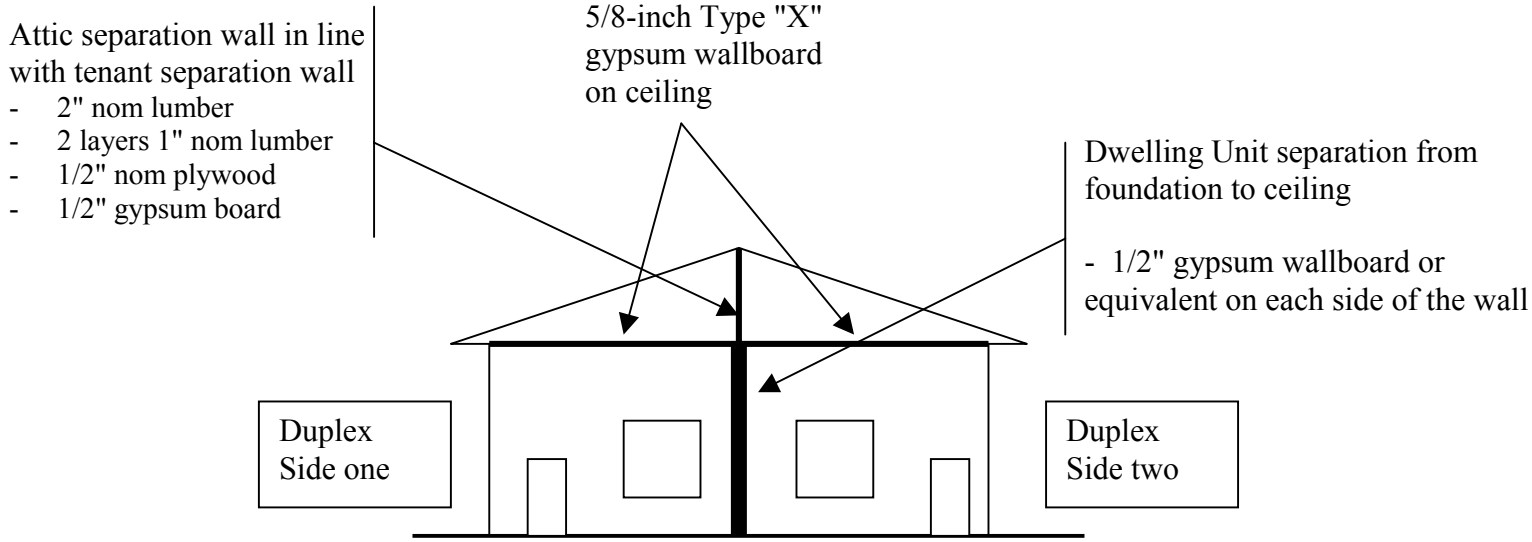
d. 1/2-inch gypsum board.

e. Fiberglass or mineral wool batt insulation may be used in an unsupported condition provided the least dimension of the opening does not exceed 4 inches.



METHOD #1
Comm 21.08 (2) (a) & (c)

NOTE: Duplexes that have access to the attic from both dwelling units are considered shared attics and shall be separated per Method #1.



METHOD #2
Comm 21.08 (2) (a), (c), (d) & (e).

(3) PENETRATIONS. (a) Ducts. 1. Except as allowed under subd. 2., all heating and ventilating ducts that penetrate a required separation shall be protected with a listed fire damper with a rating of at least 90 minutes.

2. The fire damper required under subd. 1. may be omitted in any of the following cases:

a. There is a minimum of 6 feet of continuous steel ductwork on at least one side of the penetration.

b. The duct has a maximum cross-sectional area of 20 square inches.

(b) Electrical and plumbing components. Penetrations of a required separation by electrical and plumbing components shall be firmly packed with noncombustible material or shall be protected with a listed through-penetration firestop system with a rating of at least one hour.

Question: *How do you measure the distances indicated in Table 21.08 regarding dwellings and attached/detached garages and accessory buildings?*

Answer: *Fire-rated construction may only be required in situations of a common house/garage wall or of adjoining house and garage walls that are less than 10 feet apart when measured perpendicularly from the house walls. Per Table 21.08, fire-rated construction would not be required if the distance between walls is 10 feet or more. The fire-rated construction is required only in those portions of either wall that does not meet the above test. In attached connecting breezeways or porches where there is no common wall but a common roof, the entire fire wall separation is required. This follows from the requirement that any fire separation shall extend from the top of the concrete or masonry foundation to the underside of the roof sheathing or ceiling. (See diagrams.)*

FIG. A

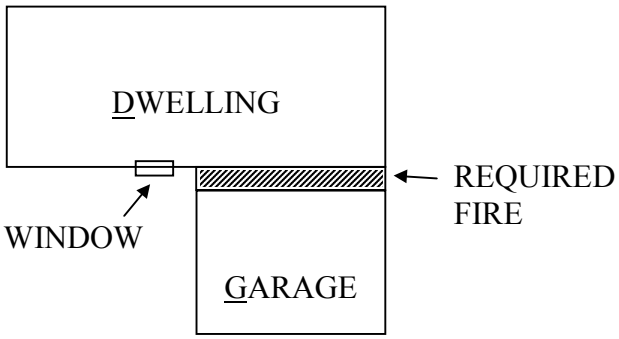


FIG. B

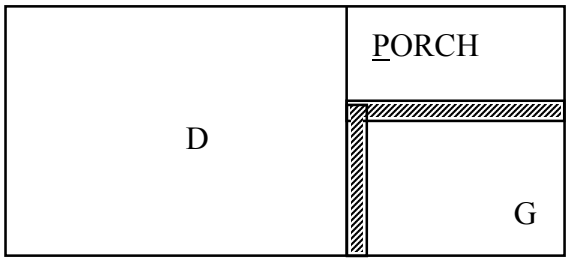


FIG. C

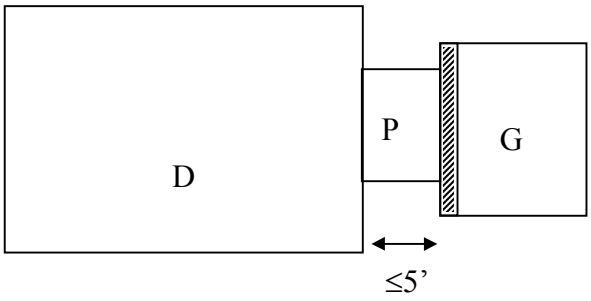


FIG. D

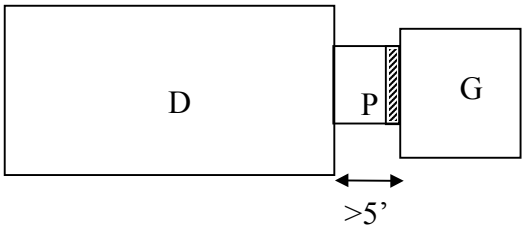


FIG. E

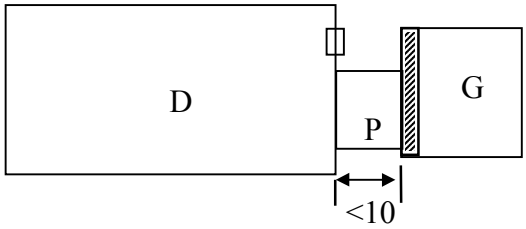


FIG. F

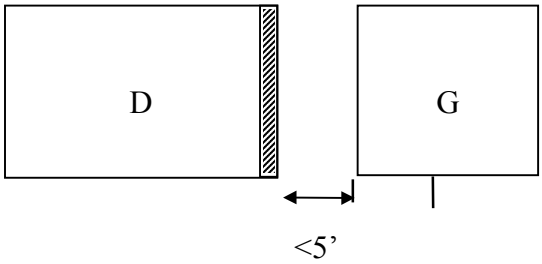


FIG. G

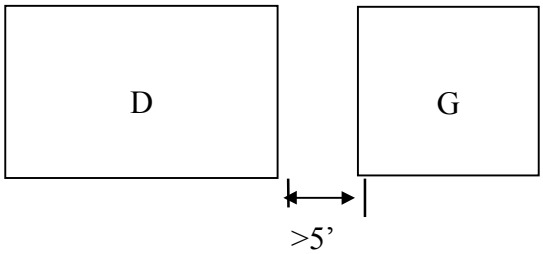


FIG. H

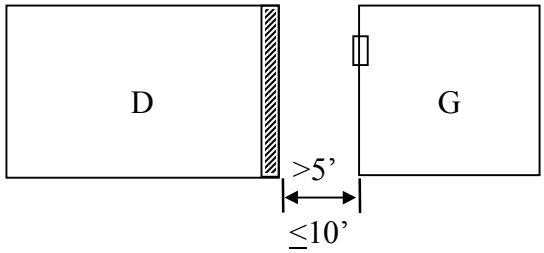
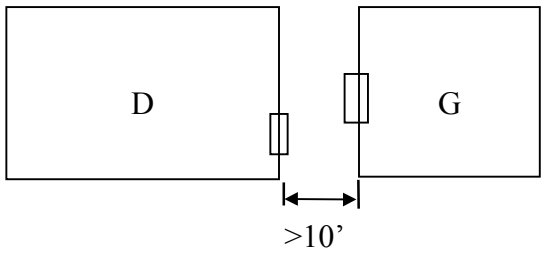


FIG. I



Comm 21.085 Fireblocking. (1) FIREBLOCKING LOCATIONS. Fireblocking shall be provided in all of the following locations:

(a) In concealed spaces of walls and partitions, including furred spaces, at the ceiling and floor levels.

(b) At all interconnections between concealed vertical and horizontal spaces including the attachment between a carport and a dwelling.

(c) In concealed spaces between stair stringers at the top and bottom of the run and at any intervening floor level.

(d) At all openings around wires, cables, vents, pipes, ducts, chimneys and fireplaces at ceiling and floor level.

(2) FIREBLOCKING MATERIALS. Fireblocking shall consist of one of the following:

(a) 2-inch nominal lumber.

(b) Two layers of one-inch nominal lumber.

(c) One thickness of 3/4-inch nominal plywood or wood structural panel with any joints backed with the same material.

(d) One thickness of 1/2-inch gypsum wallboard, face nailed or face screwed to solid wood, with any joints backed with the same material.

(e) Fiberglass or mineral wool batt insulation may be used if both of the following conditions are met:

1. The least dimension of the opening may not exceed 4 inches.

2. The batt shall be installed to fill the entire thickness of the opening or stud cavity.

(f) For wires, cables, pipes and vents only, non-shrinking caulk, putty, mortar, or similar material may be used provided no dimension of the opening exceeds 1/2 inch around the penetrating object.

(g) For chimneys, fireplaces and metal vents, fireblocking shall be metal, cement board or other noncombustible material.

Question: *How should tub/shower units be fireblocked?*
Answer: *For most units, there should be no need for fireblocking since interconnected vertical concealed spaces do not require fireblocking. However, if the unit had a canopy with a dropped soffit, then the fireblocking requirements would apply to the interconnected vertical and horizontal concealed spaces, similar to kitchen cabinet soffits. Also, the floor below a tub should be fireblocking fireblocking if it allows air/fire passage between levels within concealed spaces.*

Typical Fireblocking - Draftstopping Details

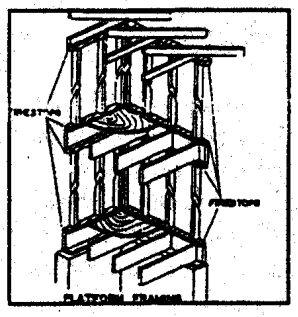
Fireblocking shall be provided in wood frame construction in the following locations:

In concealed spaces of stud walls and partitions, including furred spaces, at the ceiling and floor levels.

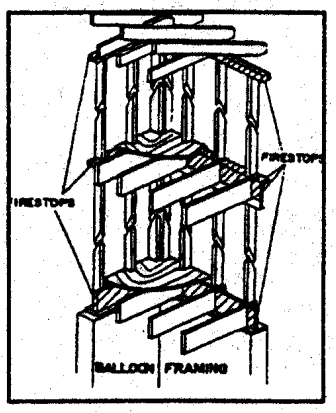
Fiberglass Insulation

Question: *Is fiberglass insulation acceptable as a fireblocking and draftstopping material?*
Answer: *Yes. This section allows other noncombustible materials in lieu of the traditional 2-inch nominal wood or drywall firestops. Unfaced fiberglass batt insulation has passed the E-136 (ASTM) test for noncombustibility. Therefore, such insulation will be allowed if it is tightly packed with materials which will be held in place and at least one dimension, length or width, of the gap to be filled is 4 inches or less, as limited by the combustibility test. Depth of the gap is not limited. These dimensions refer to the gap encountered in the direction of the fire travel as addressed by s. Comm 21.08. If a greater dimension occurs, then mechanical anchorage, such as chicken wire on both faces, shall be used.*

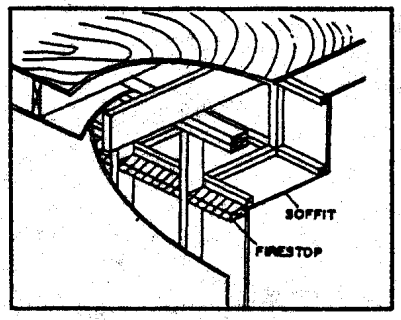
At ceiling and floor levels in platform framing. The material used for this application is framing lumber.



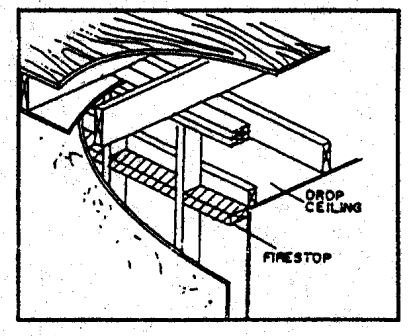
When remodeling an old house, beware of balloon framing. This framing technique is a fire hazard and must have firestops applied. The material used here is framing lumber. Balloon framed homes with cellulose insulation blown into the walls are much more firesafe than those with open cavities or more air permeable insulations.



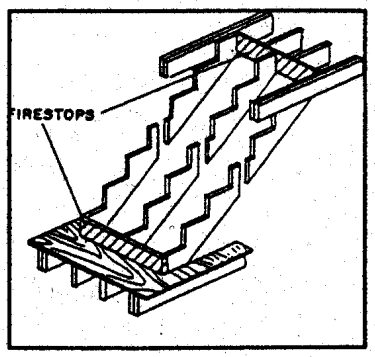
Firestopping at the soffit is critical to preventing a fire from rapidly moving into the open attic area. Material used is to be framing lumber.

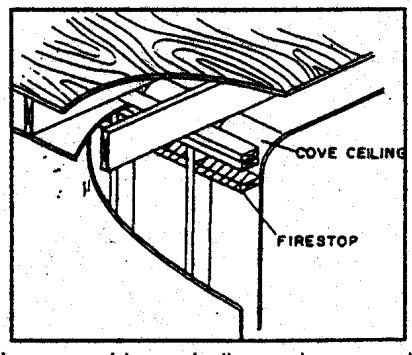


Firestopping needs to be installed below the dropped ceiling to prevent rapid movement into a large, open area. Material used is to be framing lumber.



The two firestops applied to stair stringers are critical to the firestopping system and prevent the fire from moving quickly to the area between the floors. Material is to be boards, cement board, or plywood.





Cove ceilings provide a challenge because there is insufficient wood to stop the fire against the curvature of the ceiling. Firestops must be applied against the verticle portion of the wall. Material used is to be framing lumber.

Comm 21.09 Smoke detectors.

(1) A listed and labeled multiple-station smoke alarm with battery backup shall be installed in all of the following locations:

(a) An alarm shall be installed inside each sleeping room.

(b) On floor levels that contain one or more sleeping areas, an alarm shall be installed outside of the sleeping rooms, in the vicinity of each sleeping area.

(c) On floor levels that do not contain a sleeping area, an alarm shall be installed in a common area on each floor level.

Note 1: Section 50.035 (2), Stats., created by 1983 Wis. Act 363 requires the installation of a complete low voltage, interconnected or radio-transmitting smoke detection system in all community-based residential facilities including those having 8 or fewer beds.

Note 2: Section 101.645 (3), Stats., requires the owner of a dwelling to install a functional smoke detector in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit. The occupant of such a dwelling unit shall maintain any smoke detector in that unit, except that if any occupant who is not the owner, or any state, county, city, village or town officer, agent or employe charged under statute or municipal ordinance with powers or duties involving inspection of real or personal property, gives written notice to the owner that the smoke detector is not functional the owner shall provide, within 5 days after receipt of that notice, any maintenance necessary to make that smoke detector functional.

Note 3: Section 101.745 (4), Stats., requires the manufacturer of a manufactured building to install a functional smoke detector in the basement of the dwelling and on each floor level except the attic or storage area of each dwelling unit.

Question:	*What does the "...in the vicinity of each sleeping area." mean?*
Answer:	*A "sleeping area" can include several bedrooms not separated by another use.*
Question:	*Are there other warning devices acceptable to the Department other than a listed detector?*
Answer:	*Yes, an interconnected alarm or horn that is wired into the smoke detector system is acceptable since the Department concern is to wake sleeping inhabitants and not just smoke detection. The sound levels commonly accepted as able to wake a sleeping person id 75 dba at the pillow. Remember that the following sound loss deductions:*

	Sound Loss at 1000 HZs
Stud Wall	*41 db*
Open Doorway	*4 db*

Typical Interior Door	*11 db*
Typical Fire Related Door	*20 db*
Typical Gasketed Door	*24 db*

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(2) Smoke detectors required by this section shall be continuously powered by the house electrical service, and shall be interconnected so that activation of one detector will cause activation of all detectors.

(3) For family living units with one or more communicating split levels or open adjacent levels with less than one full story separation between levels, one smoke detector on the upper level shall suffice for an adjacent lower level, including basements. Where there is an intervening door between one level and the adjacent lower level, smoke detectors shall be installed on each level.

(4) Smoke alarms and detectors shall be maintained in accordance with the manufacturer's specifications.

(5) For envelope dwellings, at least 3 smoke alarms shall be placed in the air passageways. The alarms shall be placed as far apart as possible.

Smoke Detectors

Since the 1992 edition of the UDC, a requirement for interconnection and hardwired smoke detectors has been present. Where the 1989 edition permitted battery operated units, the 1992 edition mandated detectors to be powered by house electrical service. The 1992 edition also required activation of one detector to activate all detectors. Emergency, backup or battery backup power is not required for detectors.

Note that state statute s. 101.615 requires smoke detectors in pre-UDC (June 1, 1980) dwelling similar to the UDC requirements. Chapter Comm 28 codifies these requirements for older dwellings. You may order our brochure on state smoke detectors requirements using the order form at the front of this commentary.

***Question**: If a contractor or owner wants to have additional smoke detectors over and above the minimum required by the Code, can they be battery-operated or must they be hard wired into the required system(s)?*

***Answer**: Yes, if an owner wants a battery-operated smoke detector in every room or closet, they can do that.*

***Question**: Should the smoke detectors be connected to a separate, dedicated circuit or can they be tied to any lighting or outlet circuit?*

***Answer**: Unlike fire alarm systems in commercial applications, the Department's recommendation is to connect the smoke detectors to a common lighting circuit and be connected ahead of any local switches. That way, if the circuit breaker*

trips, the owner will be aware that his smoke detector and alarms are not operational because his hallway or kitchen (etc.) lights aren't working.

Comm 21.10 Protection against decay and termites.

(1) Wood used in any of the locations specified under this section shall meet both of the following requirements:

(a) The wood shall be pressure treated with preservative or shall be a naturally durable and decay-resistant species or shall be engineered to be decay resistant.

(b) The wood shall be pressure treated with preservative or shall be naturally termite-resistant unless additional steps are taken to make the wood termite-resistant.

(2) Wood used in the following locations shall be as required under sub. (1):

(a) Embedded in earth.

(b) Floor joists that span directly over and within 18 inches of earth.

(c) Girders that span directly over and within 12 inches of earth.

(d) Sills and rim joists that rest on concrete or masonry and are within 8 inches above exterior grade.

Protection Against Decay and Termites

Question: *Comm 21.10 – An interior wood frame wall is placed on a continuous concrete footing in the basement and is used in place of a beam for support of the floor system above. The top of the footing will be level with the basement floor. Does the sole plate of this wall have to be pressure treated with a preservative or be decay-resistant lumber?*

Answer: *Subsection Comm 21.10 (1)(g) states that wood used in basements for bearing walls shall comply. This is a bearing wall and, therefore, must comply.*

(e) Siding within 6 inches of earth.

(f) Ends of wood structural members built into masonry or concrete walls and having clearances of less than 1/2 inch on the top, sides and ends.

(g) Bottom plates of load bearing walls on slab floors in basements or garages.

(h) Bottom plates of garage walls that rest on concrete or masonry and are within 8 inches of exterior grade.

(i) Columns in direct contact with concrete or masonry unless supported by a structural pedestal or plinth block at least 3 inches above the floor.

(j) Any structural part of an outdoor deck, including the decking.

(3) Wood girders that rest directly on exterior concrete or masonry shall be protected by one of the following methods:

(a) The wood shall be pressure treated with preservative or shall be a naturally durable and decay-resistant species.

(b) Material, such as pressure-treated plywood, flashing material, steel shims, or water-resistant membrane material shall be placed between the wood and the concrete or masonry.

(4) IDENTIFICATION. (a) All pressure-treated wood and plywood shall be identified by a quality mark or certificate of inspection of an approved inspection agency which maintains continued supervision, testing and inspection over the quality of the product.

(b) Pressure treated wood used below grade in foundations shall be labeled to show conformance with AWPA C-22 "Lumber and Plywood for Permanent Wood Foundations - Preservative Treatment by Pressure Processes" and labeled by an inspection agency accredited by the American Lumber Standards Committee.

Note: Heartwood of redwood, cypress, black walnut, catalpa, chestnut, osage orange, red mulberry, white oak, or cedar lumber are considered by the department to be naturally decay-resistant. Heartwood of bald cypress, redwood, and eastern red cedar are considered by the department to be naturally termite resistant.

Comm 21.11 Foam plastic insulation.

(1) (a) General. Foam plastic insulation shall have a flame-spread rating of 75 or less and a smoke-developed rating of 450 or less when tested in accordance with ASTM E-84.

(b) Thermal barrier. Except as provided in par. (c), foam plastic shall be separated from the interior of the dwelling by one of the following thermal barriers:

1. 1/2-inch gypsum wallboard.

2. 1/2-inch nominal wood structural panel.

3. 3/4-inch sawn lumber with tongue-and-groove or lap joints.

4. 1-inch of masonry or concrete.

5. A product or material shown by an independent laboratory to limit the temperature rise on the unexposed surface to 250°F for 15 minutes when tested in accordance with ASTM E-119.

6. For doors only, sheet metal with a minimum thickness of 26 standard steel gauge or aluminum with a minimum thickness of 0.032-inch.

Note: Number 26 standard steel gauge is approximately equal to 0.018 inch.

(c) Exemptions from thermal barrier requirement. The following applications of foam plastic do not require a thermal barrier.

1. On overhead garage doors.

2. In the box sill of the basement or ground floor, above the bottom of the floor joists.

(2) Insulation that does not meet the requirements of this section may be approved by the department in accordance with s. Comm 20.18. Approval will be based on tests that evaluate materials or products representative of actual end-use applications.

Foam Plastic Insulation Protection

The department has been asked whether foam plastic sheathing located on the gable ends of an unoccupied attic must be directly covered with a thermal barrier. The foam plastic is required to be separated from the living space by a thermal barrier. In this case, if a thermal barrier is located on the ceiling, such as the interior gypsum drywall, the foam plastic is adequately separated from the living space and no direct protection is required.

We have also been asked if foam plastic on the interior of a crawlspace needs to be covered. If the crawlspace does not openly communicate with an adjacent basement or other living space, then the floor sheathing is adequate to separate the foam plastic from the rest of the dwelling. However, if the crawlspace adjoins a basement or other space so that there was free air flow between the two, then the foam must be covered.

Another question has been raised about the use of foam plastic insulation on the interior of return air ducts. Sections Comm 21.11 and 23.08 prohibit the placement of unprotected combustible foam plastic on the interior of supply and return air spaces. Comm 23.08(2)(a) requires ducts to be constructed of or lined with a noncombustible material. An exception is made for unlined wood joists or stud spaces. Therefore, combustible foam plastics located on the interior of duct spaces must be protected by a noncombustible 15-minute thermal barrier.

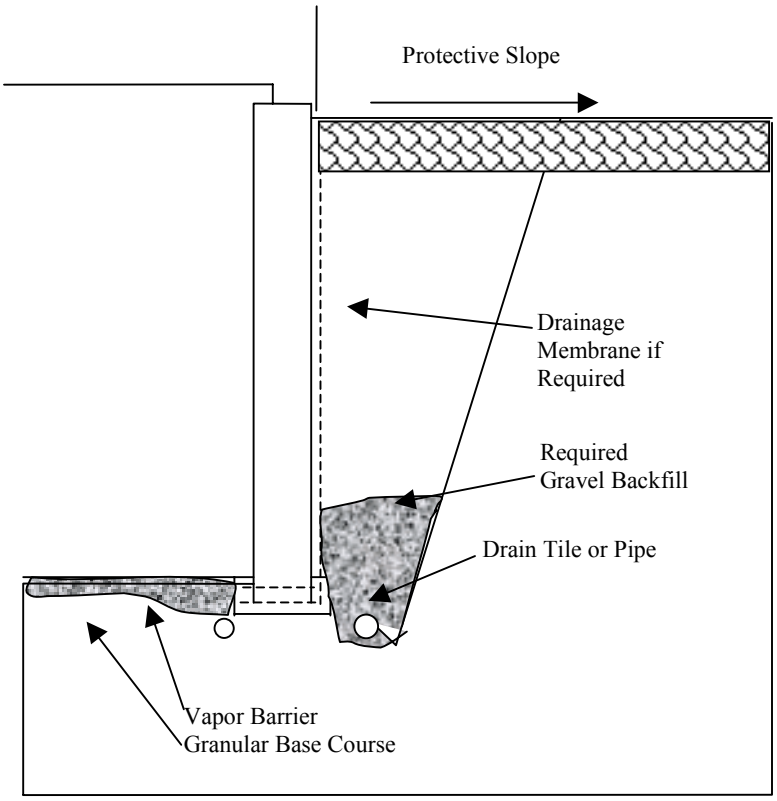
Finally it has been asked if foam insulation in attached garages needs to be protected. Yes it does because the requirement applies to any space where occupants may be present or to which they may be indirectly exposed.

An important exception to the protection requirement in the Celotex Thermax brand foam insulation which has received a Wisconsin Building Materials Approval (#950026-I) to be installed without protection. This is based on diversified testing that simulates actual fire conditions.

Subchapter III — Excavations

Comm 21.12 Grade.

The finished grade of the soil shall slope away from the dwelling at a rate of at least ½-inch per foot for a minimum distance of 10 feet, or to the lot line, whichever is less.



Comm 21.125 Erosion control procedures.

(1) PERFORMANCE STANDARDS. (a) General. Perimeter erosion control measures shall be placed within 24 hours after beginning the excavating. Erosion control measures shall be placed along downslope areas and along sideslope areas as required to prevent or reduce erosion where erosion during construction will result in a loss of soil to waters of the state, public sewer inlets or off-site. The best management practices as defined in s. Comm 20.07 (8m) or alternative measures that provide equivalent protection to these practices may be utilized to satisfy the requirements of this section. When the disturbed area is stabilized, the erosion control procedures may be removed.

(b) Stabilization by seeding and mulching. Slopes greater than or equal to 12%, with a downslope length of 10 feet or more, are not considered stabilized with seeding and mulching unless used in conjunction with a tackifier, netting, or matting. Asphalt emulsion may not be used as a tackifier.

(c) Tracking. Sediment tracked by construction equipment from a site onto a public or private paved road or sidewalk shall be minimized by providing a non-tracking access roadway. The access roadway shall be installed as approved on the plot plan, prior to framing above the first floor decking. The sediment cleanup provisions of par. (d) are unaffected by the presence or absence of an access roadway.

Note: It is not the intent of par. (c) to require a gravel access roadway where natural conditions, such as sandy soils or solidly frozen soil, already provide non-tracking access.

(d) Sediment cleanup. Off-site sediment deposition occurring as a result of a storm event shall be cleaned up by the end of the next work day following the occurrence. All other off-site sediment deposition occurring as a result of construction activities shall be cleaned up at the end of the work day.

(e) Public sewer inlet protection. Downslope, on-site public sewer inlets shall be protected with erosion control procedures.

(f) Building material waste disposal. All building material waste shall be properly managed and disposed of to prevent pollutants and debris from being carried off the site by runoff.

Note: For proper disposal of flammable, combustible and hazardous liquids, contact the local fire department.

(2) Best management practices. (a) General. Appropriate best management practices, as defined in s. Comm 20.07 (8m) or specified in chapter 3, Wisconsin Construction Site Best Management Practices Handbook, published by the department of natural resources, may be selected, installed, maintained and remain in place until the site is stabilized to meet the performance standards specified in sub. (1).

Note: The best management practices for slopes is covered under section B. 1, chapter 3, Wisconsin Construction Site Best Management Practices Handbook. For a reprint, see Table E-1 in Appendix E.

(b) Exceptions and clarification. All references to a model ordinance and planning considerations within chapter 3, Wisconsin Construction Site Best Management Practices Handbook, are not adopted by the department.

(3) MAINTENANCE OF EROSION CONTROL PROCEDURES. (a) General. During the period of construction at a site, all erosion control procedures necessary to meet the performance standards of this section shall be properly implemented, installed and maintained by the building permit applicant or subsequent landowner. If erosion occurs after building construction activities have ceased, some or all of the erosion control procedures shall be maintained until the site has been stabilized.

(b) Exceptions and clarification. The maintenance procedures and inspection sequences within chapter 3, Wisconsin Construction Site Best Management Practices Handbook, are not adopted as a part of this code.

Note: 1 The handbook is available from Document Sales, 202 South Thornton Avenue, P.O. Box 7840, Madison, Wisconsin 53707-8480; phone (608) 266-3358.

(4) DISMANTLING OF EROSION CONTROL PROCEDURES. Except for permanent erosion control systems, the owner shall be responsible for dismantling and removing erosion control procedures once the soil on the site is stabilized.

Note 2: For examples of acceptable erosion control maintenance procedures, see appendix.

UNIFORM DWELLING CODE (UDC)
EROSION CONTROL

Due to 1991 Wisconsin Act 309, effective December 1, 1992, section Comm 21.125 of the Uniform Dwelling Code (UDC) requires permit applicants to reduce the loss of soil off of new one- and two-family building sites. This section has five general areas to be addressed by the applicant - sideslope and downslope areas, vehicle tracking, sediment cleanup, sewer inlet protection, and building material waste disposal.

In order to properly address these areas, an applicant must, per s. Comm 21.125(2)(a), either comply with Chapter 3 (with some exceptions) of the Wisconsin Construction Site Best Management Practices Handbook (WCSBMPH) or other best management practices as determined by Department of Commerce per s. Comm 20.07(8m). Sections Comm 21.125(2)(b) and (3)(a) exclude those parts of the WCSBMPH dealing with the model ordinance, planning considerations, maintenance procedures and inspection sequences. The appendix to this code contains recommended maintenance procedures.

Although the Department of Commerce has not at this time determined any practices per s. Comm 20.07(8m) to be best management other than the WCSBMPH practices, s. Comm 21.125(1)(a) does allow alternative measures to 20.07(8m) if they provide equivalent protection. Therefore, the Department of Commerce grants municipal inspectors the authority to allow such alternative engineered measures on a site-by-site basis, similar to other performance code requirements.

Although the UDC only requires a reduction of off-site sedimentation to the extent affordable by the WCSBMPH practices, an applicant is still responsible per s. Comm 21.125(1)(c) for cleaning up any off-site sedimentation that breeches these practices.

While the UDC Appendix graphically reprints some of the WCSBMPH, there may be a need for the following excerpts, in citable format, of the Chapter 3 WCSBMPH practices as excluded or revised by the UDC and most often used on one- and two-family construction sites. These measures or alternative measures determined by municipal inspectors to be equivalent shall be used. Where larger disturbed areas or concentrated flows are involved, refer to the WCSBMPH itself for other measures.

Due to a lack of available research results, vegetative strips are not covered in the WCSBMPH. However, because they are defined as an erosion control procedure in the UDC, the Department of Commerce will conservatively accept them at this time. Vegetative barriers may be used as a perimeter measure if disturbed areas above consist of slopes no greater than 6 percent and barriers are on a grade no steeper than 5 percent. Vegetative barriers are to be a minimum of 10 feet wide for every 50 feet of open ground draining to them. These barriers must be maintained, i.e., not driven on or destroyed. If the barriers become covered with silt or otherwise destroyed, additional perimeter measures may be required.

SUBCHAPTER III
EXCAVATIONS

Erosion Control

Statutes Applicable To
Construction Site Erosion Control Enforcement

1. *Stats 101.653(2)* *Authorizes the Department of Commerce to promulgate UDC construction site erosion control rules. These rules are uniform statewide and supersede any municipal, including county, erosion control requirements applicable on individual building sites.*

2. *Stats 101.651* *A UDC enforcing municipality may delegate erosion control enforcement, including legal prosecutorial followup, to a county that has adopted the UDC by ordinance. (Alternatively, as pointed out above per s. Comm 21.06(1)(a), a municipality may contract with the county to provide plan review and inspection services but retain legal prosecutorial followup.)*

Question: *Who will enforce the erosion control rules?*
Answer: *In UDC - enforcing municipalities (i.e., cities, villages, towns), the local building inspector will be responsible for the enforcement of erosion control standards. This enforcement could be delegated to counties adopting such authority by ordinance.*

Question: *What about existing municipal erosion control ordinances?*
Answer: *The portions of such ordinances addressing one- and two-family dwellings are superseded by the UDC.*

Question: *Do UDC enforcing municipalities need to change their UDC ordinance to include the erosion control rules?*
Answer: *No. Because the erosion control rules will be part of the UDC, it would be similar to any update of the UDC. Therefore, if you ordinance adopts the UDC in its entirety, it will also adopt the erosion control rules.*

Question: *How may municipalities and counties recover the costs of enforcement?*
Answer: *State statutes permit them to charge fees reasonable to recover their costs of plan review and inspection.*

Question: *Do inspectors need to be certified to perform erosion control inspections?*
Answer: *Yes. Inspectors have to be certified in the UDC-Construction category. The department has also created a special Restricted UDC-Construction category for existing soil erosion inspectors. An inspector certified in this category will be restricted to soil erosion inspections <u>only</u>. To receive a soil erosion inspector certification, an inspector will have to submit a completed*

certification application form to the Department of Commerce (see address below) which demonstrates that the inspector has attended an approved training session.

Question: *What will be done to ensure that communities enforce the erosion control rules?*
Answer: *The department is required by state statute to monitor all communities enforcing an erosion control ordinance a minimum of once every three years and to provide written reports for that monitoring.*

Question: *What forms should be used for erosion control enforcement?*
Answer: *Full UDC enforcing municipalities should use the uniform building permit application and permit card.*

Question: *What resource material or training is available for helping to determine compliance with erosion control standards?*
Answer: *The DNR Best Management Practice Handbook is an excellent source of reference material as is the revised UDC Appendix. The DNR Best Management Practice Handbook may be obtained from State Document Sales, 202 South Thornton Avenue, Madison, Wisconsin 53707 (call for price 1-800-362-7253). The UDC Appendix material will be distributed with the codebook insert pages.*

FILTER FABRIC FENCES

(C) <u>Conditions Where Practice Applies</u>

(1) Downslope of disturbed areas where erosion is likely to occur in the form of sheet or rill erosion.

(3) Where the size of the drainage area is no more than 0.25 acres per 100 feet of fence length. The maximum slope length for given slopes is as follows:

DISTANCE BETWEEN PARALLEL
STRAW BALES OR SILT FENCE

Slope Percent	Slope Distance (feet)
< 2%	100 feet
2 to 5%	75 feet
5 to 10%	50 feet
10 to 20%	25 feet
>20%	15 feet

(4) Where the maximum gradient behind the fence is 50 percent (2:1).

(5) Under no circumstances may filter fabric fences be used in streams, swales, ditches or below ordinary high water marks along streams. See filter fabric barriers for conditions with concentrated flow.

(E) Design Criteria and Requirements

(1) Timing - Filter fabric fences shall be installed prior to disturbing the upslope area unless indicated otherwise on approved erosion control plan.

(2) Removal - Filter fabric fences should be removed once the disturbed area is stabilized by permanent best management practices.

(3) Placement - Silt fences shall be placed on the contour to the extent practicable. Silt fences may not be placed perpendicular to the contour on slopes of greater than 2 percent. Parallel fences may be used. The parallel spacing may not exceed the slope lengths for the appropriate slope specified above.

The ends of the fence shall be turned upslope to prevent water from running around the ends of the fence. See Figure 1 on page B.1.4. (For fences using 24-inch silt fence fabric, the ends shall be upturned at least 16 inches in elevation. For silt fences using 36-inch fabric, the ends shall be upturned at least 28 inches in elevation.)

(4) Height - Installed silt fences shall be a minimum of 14 inches high and shall not exceed 28 inches in height. (The height requirement is measured from the ground surface to the top of the fence. This does not include the anchor material.) These height requirements are designed to accommodate 24- and 36-inch silt fence fabric.

(5) Support - The full height of the silt fence shall be supported by 1 1/8" x 1 1/8" air or kiln dried posts of hickory, oak, or equivalent. The posts shall be 3 feet long for 24-inch silt fence fabric and 4 feet for 36-inch silt fence fabric. (At least 20 inches of the post shall extend into the ground after fence installation.) The silt fence fabric shall be stapled, using at least 0.5-inch staples, to the upslope side of the posts. The maximum spacing of posts for nonwoven silt fence shall be 3 feet. (No support cord is required for the 3-foot post spacing.) The maximum post spacing for nonwoven fabric with support net and top support cord, as specified below, or for woven fabric with support cord shall be 8 feet.

(6) Anchoring - The silt fence fabric shall be anchored by spreading at least 8 inches of the fabric in a 4" x 4" trench or a 4-inch deep V-trench on the upslope side of the fence as shown in Figures 1 and 2. The trench shall be backfilled and compacted.

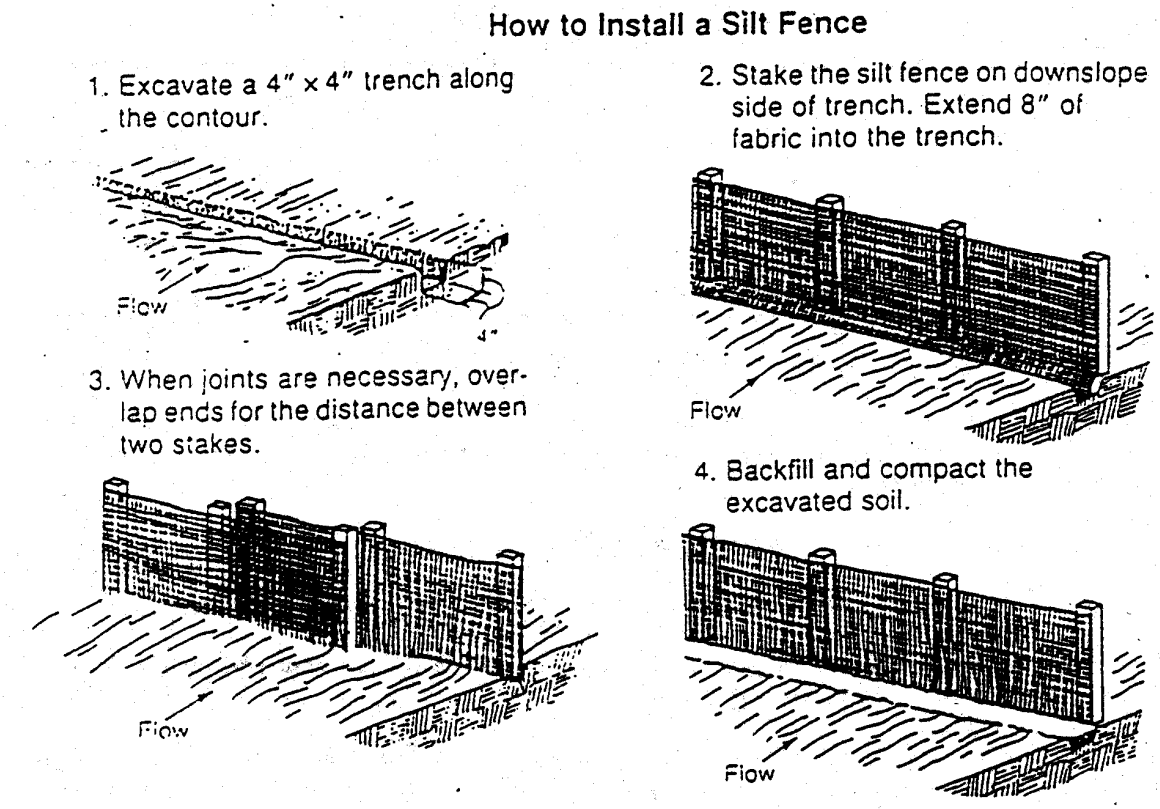
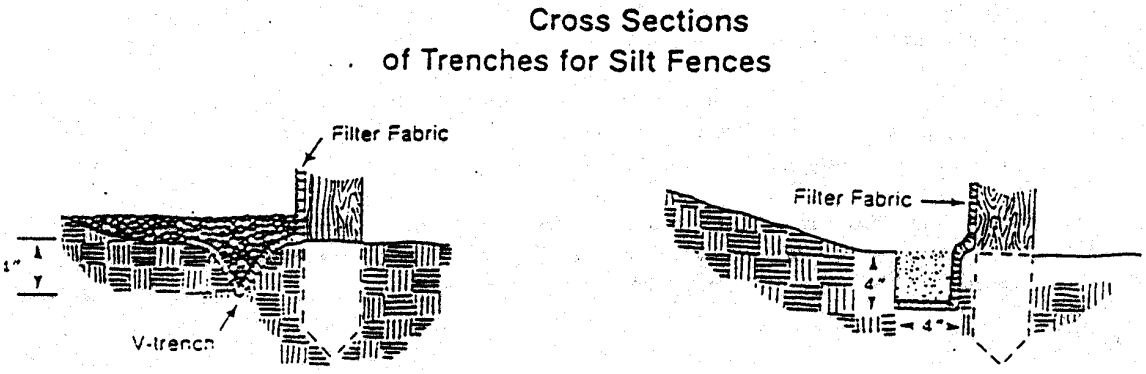


Figure E-2 Silt Fence Installation



STRAW BALE FENCES

(A) Conditions Where Practice Applies

(1) Downslope of disturbed areas where erosion is likely to occur in the form of sheet or rill erosion.

(3) Where the maximum size of the drainage area is 0.25 acres per 100 feet of fence length; the maximum length of slope behind the fence is 100 feet; and the maximum gradient behind the fence is 50 percent (2:1). The maximum slope length for given slopes is as follows:

DISTANCE BETWEEN PARALLEL
STRAW BALES OR SILT FENCE

Slope Percent	Slope Distance (feet)
< 2%	100 feet
2 to 5%	75 feet
5 to 10%	50 feet
10 to 20%	25 feet
>20%	15 feet

(4) Where pollutant control is needed for less than three months.

(5) Under no circumstances may straw bale fences be used in streams, swales, ditches or below ordinary high water marks along streams. See straw bale barriers for conditions with concentrated flow.

(B) Design Criteria and Construction Requirements

(1) Timing - Straw bale fences shall be installed prior to disturbing the upslope area.

(2) Removal - Straw bale fences may be removed once the disturbed area is stabilized by permanent best management practices.

(3) Placement - Straw bale fences shall be placed on the contour to the extent practicable. Straw bale fences may not be placed perpendicular to the contour on slopes of greater than 2 percent. The ends of the straw bale fence should be turned upslope 1 to 2 feet in elevation to prevent flanking.

(4) Entrenching - The straw bale fence shall be entrenched at least 4 inches. The upslope side of the bale shall be built up an additional 4 inches.

(5) Abutting - Straw bale fences shall be constructed by tightly abutting ends of adjacent bales. Gaps between bales shall be filled with straw.

(6) Positioning - All bales shall be either wire-bound or string-tied. Straw bales shall be installed so that bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent degradation of the bindings.

(7) Anchoring - Each straw bale shall be securely anchored by at least two stakes or re-bars driven through the bale and at least 8 inches into the ground. The first stake shall be driven towards the previously anchored bale to help create a tight fit.

MULCHING

(A) Definition

A soil surface application of plant residues or other suitable materials.

(B) Purposes

(1) To reduce erosion by dissipating raindrop impact energy and reducing overland flow and concentrated flow velocities.

(2) To foster establishment of temporary vegetative cover.

(3) To foster establishment of permanent vegetative cover.

(C) Conditions Where Practice Applies

(1) On exposed soils where additional grading or landscaping will take place.

(2) On exposed soils in conjunction with temporary or permanent seeding.

(E) Design Criteria and Construction Requirements

(2) Concentrated Flow Sites - Mulching in ditches, diversions, channels and other areas of concentrated flow shall meet the requirements of D.1. Permanent Channel Stabilization in the WCSBMPH.

(3) Preparation - The area to be mulched shall be reasonably free of sticks, stones larger than 3 inches in diameter and rills and gullies.

(4) Mulch -

a. Mulch shall be applied at the following rates:

	Tons per Acre	Pounds per 1000 Square Feet
Straw	*1.5 - 2*	*70 - 90*
Wood Chips	*6 - 9*	*275 - 412*
Wood Fiber	*0.75 - 1*	*37 - 50*

Corn Cob 5 230

b. The mulch shall be anchored at the time the mulch is spread or immediately afterwards.

(5) Nets and Mats - Erosion nets and mats including excelsior retention blankets, jute matting and polypropylene netting, shall be installed according to the manufacturer's recommendations.

FILTER FABRIC BARRIER

(A) Purpose

(1) To cause sediment carried in channelized or concentrated runoff to settle by reducing the velocity of the flow.

(B) Conditions Where Practice Applies

(1) In unstabilized minor swales, ditches or diversions where the maximum contributing area is no greater than two acres.

(2) Filter fabric barriers may not be used in intermittent and perennial stream channels.

(C) Design Criteria and Requirements

(1) Installation - Filter fabric barriers shall be installed:

a. Prior to disturbing upslope areas, or

b. Within 24 hours of constructing ditches, diversions or other channels.

(2) Removal - Filter fabric barriers shall remain in place and be maintained until disturbed upslope areas and channels, ditches and diversions are stabilized by permanent best management practices.

(3) Shape - The elevation of the barrier at the top of the filter fabric at the thread or invert location in the channel shall be lower than the bottom elevation of the ends of the barrier.

(4) Height - Filter fabric barriers shall be at least 18 inches and may not be more than 36 inches in height.

(5) Support - The full height of the filter fabric barrier shall be supported by 5-foot long, 4-inch diameter posts of equivalent and wire fence 42 inches in height. The posts shall be driven at least 12 inches into the ground. The maximum spacing of the posts shall be 10 feet. The wire fence shall be a minimum of 14 1/2 gauge and a maximum mesh spacing of 6 inches.

(6) Attaching - The filter fabric and wire mesh shall be stapled or wired to the upslope of the wire mesh with heavy duty staples at least 1 inch long, wire ties or hog rings.

(7) Entrenching - The filter fabric shall be anchored by spreading at least 8 inches of the fabric in a 4" x 4" trench on the upslope side of the barrier. The wire mesh shall extend at least 3 inches into the trench. The trench shall be backfilled and compacted.

(8) Fabric Specifications - The filter fabric shall meet the specifications of the WCSBMPH.

(9) Spacing - The spacing between fences shall be determined based on the drainage area and the difference in elevation. For unpaved contributing areas, the contributing drainage area to each filter fabric barrier may not exceed two acres. For paved contributing areas, the contributing drainage area to each filter fabric barrier may not exceed one acre. The difference in elevation between barriers may not exceed 2/3 the height of the filter fabric. (For example, a foot barrier used on a 2 percent grade with an unpaved contributing area allows the barriers to be placed 100 feet apart provided the contributing area between the barriers does not exceed two acres.)

STRAW BALE BARRIER

(A) Purpose

(1) To prevent channels from eroding by decreasing the velocity of low-to-moderate velocity and volume channel flows.

(B) Conditions Where Practice Applies

(1) In unstabilized minor swales, ditches or diversions where the maximum contributing area is no greater than two acres.

(2) Straw bale barriers may not be used in intermittent and perennial stream channels.

(C) Design Criteria and Requirements

(1) Installation - Straw bale barriers shall be installed:

a. Prior to disturbing upslope areas, or

b. Within 24 hours of constructing ditches, diversions or other channels.

(2) Removal - Straw bale barriers shall remain in place and be maintained until disturbed upslope areas and channels, ditches and diversions are stabilized by permanent best management practices.

(3) Shape - To prevent flow around the barrier, the elevation of the top of the straw bale barrier at the thread of invert location in the channel shall be lower than the bottom elevation of the ends of the barrier as illustrated in Figure 1.

(4) Positioning - Straw bales barriers shall be installed so that the bindings are oriented around the sides rather than along the tops and bottoms of the bales to prevent deterioration of the bindings. Gaps between bales shall be chinked (filled by wedging) with straw to prevent water from flowing between bales.

(5) Anchoring - The straw bale shall be anchored by at least two stakes or re-bars driven through each bale. The first stake shall be driven towards the previously anchored bale to force the bales together. The stakes shall be driven deep enough to securely anchor the bale.

(7) Entrenching - The straw bale fence shall be entrenched at least 4 inches. The upslope side of the bale shall be built up an additional 4 inches.

(8) Spacing - The spacing between fences shall be determined based on the drainage area and the difference in elevation. For unpaved contributing areas, the contributing drainage area to each straw bale barrier may not exceed two acres. For paved contributing areas, the contributing drainage area to each straw bale barrier may not exceed one acre. The difference in elevation between barriers may not exceed 2/3 the height of the straw bale. (For example, a 3-foot barrier used on a 2 percent grade with an unpaved contributing area allows the barriers to be placed 100 feet apart provided the contributing area between the barriers does not exceed two acres.)

TEMPORARY GRAVELED ACCESS ROADS

(A) Definition

(1) A gravel stabilized pad located at points of vehicular access and parking on the construction site.

(B) Design Criteria and Requirements

(1) Timing - The graveled access shall be installed as soon as practicable or no later than the time of backfill.

(2) Removal - The graveled access shall remain in-place and be maintained until the disturbed area is stabilized by permanent best management practices.

(3) Location - The graveled access shall be located to provide maximum use by all construction vehicles.

(4) Dimensions - The graveled access should consist of at least 6 inches of 2- to 3-inch aggregate; 50 feet in length or the distance from the road to the specific construction area, whichever is less; and at least 7 feet in width. The width shall be 14 feet if it is necessary to have vehicles pass on the site.

Comm 21.13 Excavations adjacent to adjoining property.

(1) NOTICE. Any person making or causing an excavation which may affect the lateral soil support of adjoining property or buildings shall provide at least 30 days written notice to all owners of adjoining buildings of the intention to excavate. The notice shall state that adjoining buildings may require permanent protection.

(a) Exception. The 30-day time limit for written notification may be waived if such waiver is signed by the owner(s) of the adjoining properties.

(2) RESPONSIBILITY FOR UNDERPINNING AND FOUNDATION EXTENSIONS. (a) Excavations less than 12 feet in depth. If the excavation is made to a depth of 12 feet or less below grade, the person making or causing the excavation shall not be responsible for any necessary underpinning or extension of the foundations of any adjoining buildings.

(b) Excavations greater than 12 feet in depth. If the excavation is made to a depth in excess of 12 feet below grade, the owner(s) of adjoining buildings shall be responsible for any necessary underpinning or extension of the foundations of their buildings to a depth of 12 feet below grade. The person making or causing the excavation shall be responsible for any underpinning or extension of foundations below the depth of 12 feet below grade.

Comm 21.14 Excavations for footings and foundations.

(1) EXCAVATIONS BELOW FOOTINGS AND FOUNDATIONS. No excavation shall be made below the footing and foundation unless provisions are taken to prevent the collapse of the footing or foundation.

(2) EXCAVATIONS FOR FOOTINGS. All footings shall be located on undisturbed or compacted soil, free of organic material, unless the footings are reinforced to bridge poor soil conditions.

Subchapter IV — Footings

Comm 21.15 Footings.

The dwelling shall be supported on a structural system designed to transmit and safely distribute the loads to the soil. The loads for determining the footing size shall include the weight of the live load, roof, walls, floors, pier or column, plus the weight of the structural system and the soil over the footing. Footings shall be sized to not exceed the allowable material stresses. The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing values of the soil.

(1) SIZE AND TYPE. Unless designed by structural analysis, unreinforced concrete footings shall comply with the following requirements:

(a) Continuous footings. The minimum width of the footing on each side of the foundation wall shall measure at least 4 inches wider than the wall. The footing depth shall be at least 8 inches nominal. Footing placed in unstable soil shall be formed. Lintels may be used in place of continuous footings when there is a change in footing elevation.

Note: Unstable soil includes soils which are unable to support themselves.

(b) Column or pier footing. The minimum width and length of column or pier footings shall measure at least 2 feet by 2 feet. The depth shall measure at least 12 inches nominal. The column shall be so placed as to provide equal projections on each side of the column.

(c) Trench footings. Footings poured integrally with the wall may be used when soil conditions permit. The minimum width shall be at least 8 inches nominal.

(d) Chimney and fireplace footings. Footing for chimneys or fireplaces shall extend at least 4 inches on each side of the chimney or fireplace. The minimum depth shall measure at least 12 inches nominal.

(e) Floating slabs. Any dwelling supported on a floating slab on grade shall be designed through structural analysis. Structures supported on floating slabs may not be physically attached to structures that are supported by footings that extend below the frost line unless an isolation joint is used between the structures.

(f) Deck footings. Decks attached to dwellings and detached decks which serve an exit shall be supported on a structural system designed to transmit and safely distribute the loads to the soil. Footings shall be sized to not exceed the allowable material stresses. The bearing area shall be at least equal to the area required to transfer the loads to the supporting soil without exceeding the bearing values of the soil.

Question: *Are there conditions when a drilled or hand-dug pier foundation could be used in lieu of a 24" x 24" x 12" footing and concrete formed column be used and still comply with the UDC?*

Answer: *Yes, many times the deck loads transferred to deck piers are relatively small and these loads could be carried by the minimum soil bearing capacity (2000 psf) without a separate footing. As an example, a 10" round concrete pier poured on 2000 psf soil could carry a concentrated deck load of 1090 pounds per pier. Therefore if you know your deck loading information you can determine the center to center locations needed for the deck.*

Deck Column Footing Size

Deck footings are required to be designed with a bearing area equal or greater than the area required to transfer live and dead loads to the supporting soil without exceeding the bearing value of the soil. In lieu of a designed footing, the code required minimum size or a column footing of 24" x 24' x 12" thick should be used in accordance with Comm 21.15(1)(b). In designing a column footing for a deck, the following steps should be utilized:

1) *Calculate the tributary area for floor and any roof area that the column carries.*

2) Multiply the floor area by the code required live load and actual dead loads. Do the same for any roof area.

3) Divide the total load from 2) by the allowable soil bearing value listed in the Table at the end of s. Comm 21.15(2) to find the minimum footing size in square feet.

4) To provide adequate spread of the load through the concrete or gravel footer, its thickness should be at least one-half of its diameter, but in no case less than 8".

(2) SOIL-BEARING CAPACITY. No footing or foundation shall be placed on soil with a bearing capacity of less than 2,000 pounds per square foot unless the footing or foundation has beeen designed through structural analysis. The soil-bearing values of common soils may be determined through soil identification.

Note: The department will accept the soil-bearing values for the types of soil listed in the following table:

Type of Soil	PSF
1. Wet, soft clay; very loose silt; silty clay	2,000
2. Loose, fine sand; medium clay; loose sandy clay soils	2,000
3. Stiff clay; firm inorganic silt	3,000
4. Medium (firm) sand; loose sandy gravel; firm sandy clay soils; hard dry clay	4,000
5. Dense sand and gravel; very compact mixture of clay, sand and gravel	6,000
6. Rock	12,000

(a) Minimum soil-bearing values. If the soil located directly under a footing or foundation overlies a layer of soil having a smaller allowable bearing value, the smaller soil-bearing value shall be used.

(b) Unprepared fill material, organic material. No footing or foundation shall be placed upon unprepared fill material, organic soil, alluvial soil or mud unless the load will be supported. When requested, soil data shall be provided.

Note: The decomposition of organic material in landfill sites established for the disposal of organic wastes may produce odorous, toxic and explosive concentrations of gas which may seep into buildings through storm sewers and similar underground utilities unless provisions are taken to release the gases to the atmosphere.

Comm 21.16 Frost penetration.

(1) GENERAL. Footings and foundations, including those for ramps and stoops, shall be placed below the frost penetration level, but in no case less than 48 inches below grade measured adjacent to the footing or foundation. Footings shall not be placed over frozen material.

(2) EXCEPTIONS. (a) Floating slabs constructed on grade need not be installed below the minimum frost penetration line provided measures have been taken to prevent frost forces from damaging the structure.

(b) Grade beams need not be installed to the minimum frost penetration line provided measures are taken to prevent frost forces from damaging the structure.

(c) Stoops or ramps need not be installed below the minimum frost penetration level provided measures are taken to prevent frost forces from damaging the structure.

(d) Footings or foundations may bear directly on rock located less than 48 inches below grade. Prior to placement, the rock shall be cleaned of all earth. All clay in the crevices of the rock shall be removed to the level of frost penetration or 1-1/2 times the width of the rock crevice. Provisions shall be taken at grade to prevent rain water from collecting along the foundation wall of the building.

(e) Portions of footings or foundations which are located directly below window areaways which are required to be installed in accordance with s. Comm 21.03 (6m), are exempt from the requirements of sub. (1).

Frost Penetration

Question: *How does one determine if the local frost penetration is greater than the 48-inch minimum requirement by code?*

Answer: *In most cases, you will find that the average frost depth does not exceed the 48-inch depth. A good source for the average local conditions of frost is to check with the people involved with the installation of utilities or grave digging.*

Exception to Frost Penetration Rule

This section generally requires a 48-inch footing depth to prevent frost damage. There are some exceptions to allow lesser footing depths provided measures are taken to prevent frost heave damage to the structure.

Some measures which may be considered to help prevent damage, if over and above the code minimum requirements, include:

- *Verification of good soils (well-drained, granular) which may be less subject to retaining water which may freeze and expand.*
- *Additional drainage at the affected footing in conjunction with good surface drainage.*
- *Providing reinforcement in the affected footing and/or foundation wall.*
- *Providing reinforced perimeter grade beams in slab-on-grade construction.*
- *Providing a mechanical tie or continuous reinforcement to bind the stoops or ramps to the foundation wall to resist relative movement. This would help prevent obstruction of exit doors or gaps at the wall to stoop interface.*

- *Overdesigning the foundation or structure to recognize the potential for some soil-caused deflection.*

- *Insulate the soil around the building perimeter with foam board laid horizontally just below the ground surface – see Chapter 22 and Appendix.*

Most times a qualified engineer should make the determination which of the above, or other, measures is inherent in the situation or may be required to gain code compliance. The engineer's report should be submitted to the local inspector for approval.

Question: *Are frost-protected footings allowed and what standards must be followed in the construction of footings or slabs-on-grade without going below frost levels?*

Answer: *Yes. Frost-protected footings are allowed. Frost-protected footings (FPF) is an internationally recognized and accepted technique of protecting slab-on-grade foundations of heated buildings against frost action. The FPFs use rigid horizontal perimeter insulation to reduce heat loss from the ground around the dwelling. This heat keeps the ground from freezing and frost action on the structure. The FPFs have been used in Scandinavian countries since the 1950s and more recently in the United States. At this time the department accepts FPFs installed in accordance with those designs that assume the building is unheated. This is a conservative design that allows for the possibility of the dwelling being unoccupied and unheated during some winters of the dwelling's lifetime. See UDC Appendix.*

Comm 21.17 Drain tiles.

(1) DETERMINATION OF NEED. (a) New construction. 1. Except as provided under sub. (2), a complete drain tile or pipe system shall be installed around the foundation of dwellings under construction where groundwater occurs above the bottom of the footing.

2. For the purposes of this section, a complete drain tile or pipe system includes the drain tile or pipe installed inside and outside the foundation at the footing level, bleeders connecting the inside tile or pipe to the outside tile or pipe, the sump pit, the discharge piping, and a pump or means of discharging water to natural grade.

(b) Optional systems. 1. If a complete drain tile or pipe system is not required by natural conditions under par. (a) or by a municipality exercising jurisdiction under sub. (2) (a), a partial drain tile or pipe system may be installed.

2. For the purposes of this section, a partial drain tile or pipe system may include any of the elements under par. (a) 2.

(2) Municipalities exercising jurisdiction. (a) New construction. 1. For new dwelling construction, a municipality exercising jurisdiction under this code may determine the soil types and natural or seasonal groundwater levels for which a complete drain tile or pipe system is required.

2. For new dwelling construction, a municipality may not enact requirements for other than complete drain tile or pipe systems.

(b) Alterations to an existing dwelling. For an alteration to an existing dwelling covered by this code, a municipality may not require a complete drain tile or pipe system.

(c) Partial systems. Municipalities may allow partial drain tile or pipe systems for new dwellings under construction or existing dwellings.

Determination of Drain Tiles Need

Where municipalities exercise jurisdiction over requiring drain tile within their community, they should provide sufficient notice to the building permit applicant by indicating to the applicant at the time that the plans are approved how the municipality handles enforcement of drain tile. This means that the municipality, plan reviewer, or inspector should at the time the plans are approved indicate whether or not the community will require drain tile to be provided with Comm 21.17, not require drain tile to be provided, or will make a determination as to whether or not drain tile will be required upon an inspection visit to the excavated site. This allows the communities to either have a blanket policy of a requirement or nonrequirement for drain tile, and still allows them the flexibility to make that determination upon viewing the excavation, wherein they can determine soil types and sometimes water elevation. It is the department's position that for the drain tile requirement, the decision should be made as early on in the permit, plan review, inspection process as possible.

TABLE 1
TYPES OF SOILS AND THEIR DESIGN PROPERTIES

Soil Group	Unified Soil Classification System Symbol	Soil Description	Allowable Bearing in Pounds Per Square Foot with Medium Compaction or Stiffness[4]	Drainage Characteristics[2]	Front Heave Potential	Volume Change Potential Expansion
Group I Excellent	GW	Well-graded gravels, gravel sand mixtures, little or no fines.	8000	Good	Low	Low
	GP	Poorly-graded gravels or gravel sand mixtures, little or no fines.	8000	Good	Low	Low
	SW	Well-graded sands, gravelly sands, little or no fines.	6000	Good	Low	Low
	SP	Poorly-graded sands or gravelly sands, little or no fines.	5000	Good	Low	Low
	GM	Silty gravels, gravel-sand-silt mixtures.	4000	Good	Medium	Low
	SM	Silty sand, sand-silt mixtures.	4000	Good	Medium	Low
Group II Fair to Good	GC	Clayey gravels, gravel-sand-clay mixtures.	4000	Medium	Medium	Low
	SC	Clayey sands, sand-clay mixtures.	4000	Medium	medium	Low
	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity.	2000	Medium	High	Low
	CL	Inorganic clays of low to medium plasticity, gravelly clays, sand clays, silty clays, lean clays	2000	Medium	Medium	Medium[1] to Low
Group III	CH	Inorganic clays of high plasticity, fat clays	2000	Poor	Medium	High[1]
	MH	Inorganic silts,	2000	Poor	High	High

Poor		micaceous or distomaceous fine sandy or silty soils, elastic silts.				
Group IV Unsatisfactory	OL	Organic silts and organic silty clays of low plasticity.	400	Poor	Medium	Medium
	OH	Organic clays of medium to high plasticity, organic silts.	-0-	Unsatisfactory	Medium	High
	P_t	Peat and other highly organic soils.	-0-	Unsatisfactory	Medium	High

[1] Dangerous expansion might occur if these two soil types are dry but subject to future wetting.

[2] The percolation rate for good drainage is over 4 inches per hour, medium drainage is 2 to 4 inches per hour, and poor is less than 2 inches per hour.

[3] Building code allowable bearing values may differ from those tabulated.

[4] Allowable bearing value may be increased 25 percent for very compact, coarse grained gravelly or sandy soils or very stiff fine-grained clayey or silty soils. Allowable bearing value shall be decreased 25 percent for loose, coarse-grained gravelly or sandy soils, or soft, fine-grained clayey or silty soils. To determine compactness or stiffness to estimate allowable bearing capacity, measure the number of blows required to drive a 2-inch outside diameter, 1.375-inch inside diameter split-barrel sampler 1 foot into the soil by dropping a 140-pound hammer through a distance of 30 inches.

In response to questions and concerns regarding work continuing after an inspection has not been carried out after the 48-hour requirement, municipalities and inspectors should inform the builder or owner that they are proceeding at their own risk, and at the time the municipality or inspector makes the inspection they may still require the drain tile to be provided in accordance with Comm 21.17.

A municipality may use various criteria other than a soil test report (per s. Comm 21.17(1)(b)) to determine where drain tile systems are required. Such criteria may include county soil maps, direct observation of standing water in the excavation, and experience with other sites in the locality. There is substantial discretion given to the local inspector. It is recommended that the criteria for this local discretion, or municipal policy, be uniformly applied within the municipality and expressed to builders before construction.

Where no local inspector is provided by the municipality, the code requires the owner and builder to install drain tiles where a soil test indicates periodic or seasonal groundwater at the footing. Often times such homes are also in unsewered areas. The soil test report for a private sewage system will indicate depth to seasonal groundwater. This report may be used to determine dwelling drain tile requirements if the house site is close to and is similar in soil and drainage characteristics to the private sewage system site.

If a private sewage system soils report is not available or applicable, then the owner or builder may retain a qualified soils consultant (engineer, certified soil tester) to determine groundwater depth or rely on the experience of other projects in the area, if relevant.

(3) MATERIALS AND INSTALLATION REQUIREMENTS FOR REQUIRED SYSTEMS. (a) General. Complete drain tile or pipe systems required by natural conditions under sub. (1) (a) or by a municipality exercising jurisdiction under sub. (2) (a) shall comply with the requirements of this subsection.

(b) Basement floor slabs. The basement slab shall be placed on at least 4 inches of clean graded sand, gravel or crushed stone.

(c) Manufactured drainage systems. Manufactured drainage systems not meeting the requirements of this section shall be submitted to the department for review and approval prior to installation.

(d) Drain tile or pipe installation. Drain tile or pipe used for foundation drainage shall comply with the following requirements:

1. Drain tile or pipe shall have an inside diameter of at least 3 inches.

2. Drain tile or pipe shall have open seams, joints, or perforations to allow water to enter.

3. Where individual tiles are used, they shall be laid with 1/8 inch open joints. Joints bettween tiles shall be covered with a strip of sphalt or tar impregnated felt.

4. The tile or pipe shall be placed upon at least 2 inches of coarse aggregate and shall be covered on the top and the side facing away from the dwelling with a least 12 inches of coarse aggregate that meets all of the following criteria:

a. 100% of the aggregate shall pass a 1-inch sieve.

b. 90-100% of the aggregate shall pass a 3/4-inch sieve.

c. 0-55% of the aggregate shall pass a 3/8-inch sieve.

d. 0-5% of the aggregate shall pass a #8 sieve.

Note 1: A #8 sieve has square openings of 2.36 mm or 0.09 inch.

Note 2: These specifications encompass aggregate sizes #6 and #67 per ASTM standard C33. Of the two sizes, #6 is coarser.

5. Bleeder tiles or pipes shall be provided at no more than 8-foot intervals to connect the exterior drain tile or pipe to the interior drain tile or pipe.

Question:	*Are bleeder tiles required to connect interior and exterior drain tile?*
Answer:	*Yes. Comm 21.17(3)(d) 5. requires bleeder tiles to connect to interior and exterior drain tile. The drain tile may be provided with a tee for connection or cut, NOT just butted together, to fit to the bleeder. In either case, the intent is to permit the free flow of water once it has reached the exterior drain tile thereby reducing any hydraulic pressure at the footing, foundation wall and basement slab.*

6. The drain tiles or pipe that lead from the footing tiles to the sump pit shall be laid at a grade of at least 1/8 inch per foot leading to the sump pit. The remaining drain tiles or pipe shall be level or graded downward to the line leading to the sump pit.

Question: *If a drain tile "sock" is used, can I eliminate some or all of the coarse aggregate?*

Answer: *No, the tile "sock" doesn't replace any of the coarse aggregates function and therefore, if used, is only an added safe guard against fines clogging the tile weeps. With some types of soils the "sock" actually hold certain types of fines and can cause basement water problems, so it is not recommended to use this type of 'socked'*

Question: *What is the proper location for drain tile at the footing or on the footing?*

Answer: *Drain tile is to be placed AT the footing level, not setting on the footing, as the code is specific in Comm 21.17 (3)(d) 4. that the tile must set on 2 inches of coarse aggregate and be covered with at least 12 inches of coarse aggregate.*

Question: *The code talks about the placement of drain tile on 2 inches of coarse aggregate and being covered with 12 inches of coarse aggregate; but how much coarse aggregate is to be placed on the side of the tile?*

Answer: *As the code states "covered with at least 12 inches of coarse aggregate," this includes the outside or side exposed to earth of the tile as well as the top. Normally since one side of the tile (connected to the bleeders) is up against the footing, only the top and side needs the 12 inches of cover.*

Drain Tiles - Materials and Installation Requirements

A properly functioning drain tile system will lower the water table (seasonal or longer term) to the level of the tile installation in the immediate vicinity of the foundation wall.

This is important not only to achieve a relatively dry basement, but to maintain the structural integrity of the home. A saturated soil is not only heavier than dry soil, but it also has less internal soil friction that normally helps restrain lateral soil flow. Therefore, the potential lateral pressures exhibited by saturated soils are significantly greater than well-drained foundation backfill. Also a well-drained soil is less likely to frost heave when frozen.

The tile, backfill, and discharge (sump) systems are designed to maximize drainage and minimize potential siltation and overload of the system. A well-graded gravel bed and porous backfill are important for proper drain system operation. Also, per s. Comm 21.12, the grade around the dwelling should slope away to minimize the need for the drain tile to handle surface water surcharge.

This office has received some complaints about sump pump systems operating continuously. Contrary to the complainant's concerns, this is usually evidence of a properly functioning system. The real problem is that groundwater in the area is at a relatively shallow depth, local soils are porous, or both. This results in a high volume of flow. These are conditions

that should have been considered in making the decision where to site the building by the owner and builder.

Such situations normally occur in lowland areas, where water tables are perched above poor drainage strata, where surface drainage is bad, or where soils are very porous (fractured limestone, gravels, some sand) that allow easy lateral soil water movement. Zoning laws and subdivision ordinances more appropriately regulate whether certain parcels of land should be developed and/or what floor elevation is required given these conditions. However, zoning codes may not further regulate construction of the foundation drainage systems.

(e) Drain tile or pipe discharge. 1. Drain tiles or pipe shall be connected to the sump pit.

2. The sump pit shall discharge to natural grade or be equipped with a pump.

Care should be taken not to allow sump discharge to cause erosion which would result in sediment being deposited off site.

3. All other aspects of drain tile discharge shall be in accordance with the uniform plumbing code, chs. Comm 82 to 87.

Note: The following is a reprint of the pertinent sections of the plumbing code.

Comm 82.36 (11) SUMPS AND PUMPS. (a) Sumps. 1. General. All storm building subdrains shall discharge into a sump, the contents of which shall be automatically lifted and discharged into the storm drain system.

2. Construction and installation. a. Except as specified in subd. 2. b., the sump shall have a rim extending at least one inch above the floor immediately adjacent to the sump. The sump shall have a removable cover of sufficient strength for anticipated loads. The sump shall have a solid bottom.

b. Where the sump is installed in an exterior meter pit or elevator pit, the rim shall be level with the floor.

3. Location. All sumps installed for the purpose of receiving clear water, basement or foundation drainage water shall be located at least 15 feet from any water well.

4. Size. The size of each clear water sump shall be as recommended by the sump pump manufacturer, but may not be smaller than 16 inches in diameter at the top, 14 inches in diameter at the bottom, and 22 inches in depth.

5. Removable covers. a. Except as specified in subd. 5. b., penetrations through the top of removable sump covers shall be limited to those for the electrical supply, the vent piping and the discharge piping for the pump or pumps.

b. A sump installed in an exterior meter pit or an elevator pit may be provided with an open grate cover.

Note: In accordance with s. Comm 18.21, a sump may not be located in an elevator machine room.

(b) Sump pump systems. 1. Pump size. The pump shall have a capacity appropriate for anticipated use.

2. Discharge piping. Where a sump discharges into a storm building drain or sewer, a free flow check valve shall be installed.

Comm 82.36 (3) DISPOSAL. (a) Storm sewer. Storm water, surface water, groundwater and clear water wastes shall be discharged to a storm sewer system or a combined sanitary-storm sewer system where available. Combined public sanitary-storm sewer systems shall be approved by the department of natural resources. Combined private sanitary-storm sewer systems shall be approved by the department.

(b) Other disposal methods. 1. Where no storm sewer system or combined sanitary-storm sewer system is available or adequate to receive the anticipated load, the final disposal of the storm water, surface water, groundwater or clear water wastes shall be discharged in accordance with local governmental requirements. If the final disposal of such waters or wastes is by means of subsurface discharge, documentation shall be submitted to this department to determine whether the method of disposal is acceptable.

2. Where approved by the local governmental authority, storm water, surface water, groundwater and clear water wastes of the properties of one- and 2-family dwellings may be discharged onto flat areas, such as streets or lawns, so long as the water flows away from the buildings and does not create a nuisance.

3. The waste from a drinking fountain, water heater relief valve, storage tank relief valve, water softener, or iron filter shall be discharged to a sanitary drain system or a storm drain system.

Note: See also s. NR 811.29 for setbacks to wells.

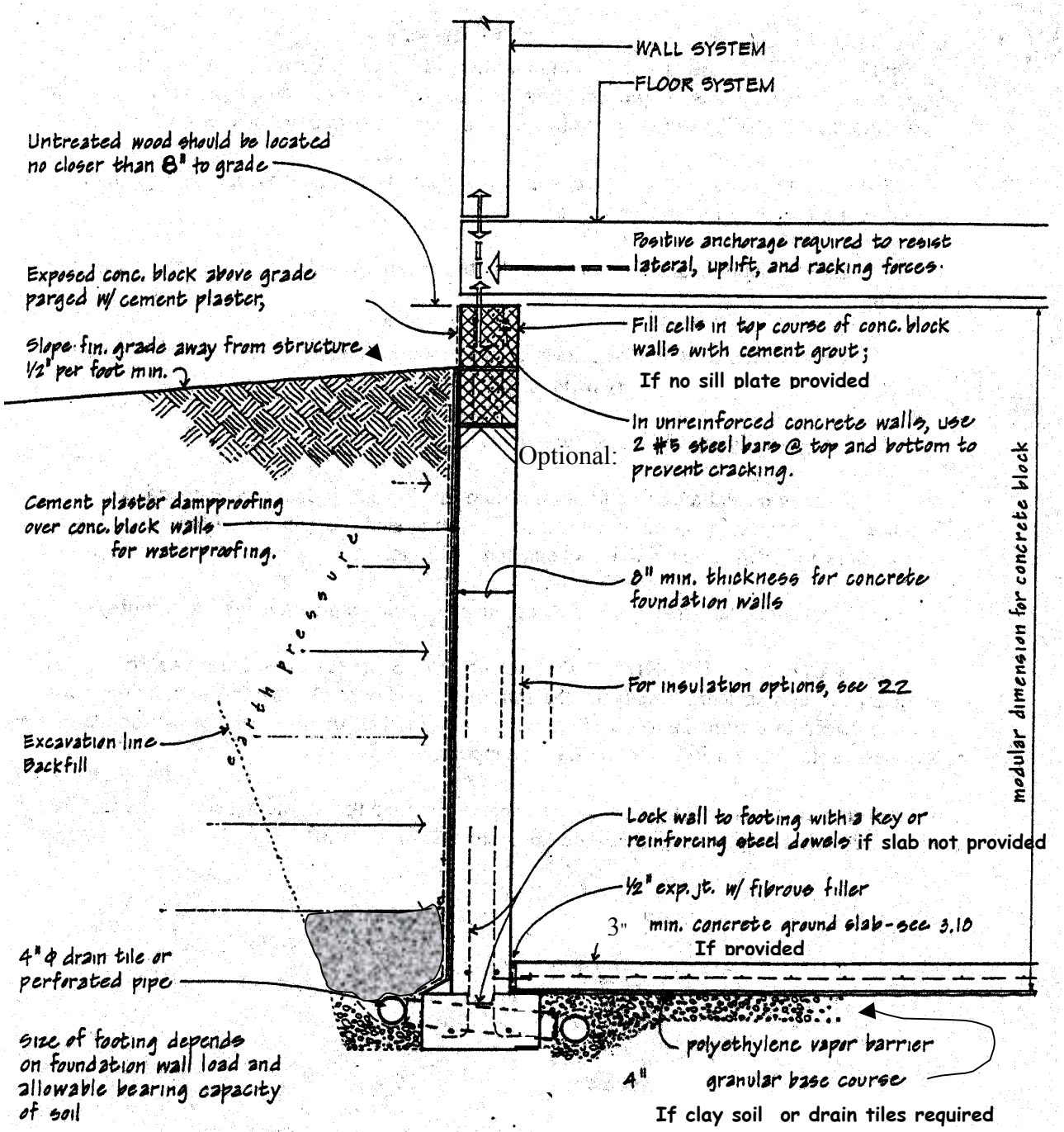
4. The clear water wastes from equipment other than those listed in subd. 3. may be discharged to a sanitary drain system which connects to a publicly owned treatment works, if not more than 20 gallons of clear water wastes per day per building are discharged.

5. The wastes from a floor drain located in a municipal well pump house, a water testing sink within a municipal well pump house or a one- and 2-family garage shall be discharged to a sanitary drain system or to ground surface.

(c) Segregation of wastes. 1. a. Except as provided in subd. 1. b., where a sanitary sewer system and a storm sewer system are available the drain piping for storm water or clear water wastes may not connect to any part of the sanitary drain system.

b. Where a combined sanitary-storm sewer system is available storm water wastes, clear water wastes and sanitary wastes may not be combined until discharging to the building sewer.

2. Storm water wastes and clear water wastes shall not be combined until discharging into the storm building drain.



FOUNDATION WALL SECTION

Subchapter V — Foundations

Comm 21.18 Foundations.

(1) GENERAL. (a) Design. Foundation walls shall be designed and constructed to support the vertical loads of the dwelling, lateral soil pressure, and other loads without exceeding the allowable stresses of the materials of which the foundations are constructed.

(b) Lateral support at base. Lateral support such as floor slabs or framing shall be provided at the base of foundation walls.

(c) Lateral support at top. Lateral support shall be provided at the top of the foundation walls by one of the following:

2. 'Structural analysis.' A system designed through structural analysis.

3. 'Anchor bolts.' a. Structural steel anchor bolts, at least 1/2 inch in diameter, embedded at least 7 inches into the grouted masonry with a maximum spacing of 72 inches and located within 18 inches of wall corners.

b. A properly sized nut and washer shall be tightened on each bolt to the plate or sill.

c. When vertical-reinforcing steel is provided in masonry construction, as required under sub. (3), the location requirements under subd. 3. a. shall be modified as necessary so anchor bolts are placed in the same core as the reinforcement without exceeding the limits of subd. 3. a.

4. 'Other mechanical fasteners.' a. Mechanical fasteners used in accordance with the manufacturer's testing and listing.

b. When vertical-reinforcing steel is provided in masonry construction, as required under sub. (3), the location requirements under subd. 4. a. shall be modified as necessary so the fasteners are placed in the same core as the reinforcement without exceeding the limits of subd. 4. a.

(d) Floor framing. 1. Floor framing shall be fastened to the sill plate by one of the following methods:

a. Mechanical fasteners used in accordance with the manufacturer's testing and listing.

b. In accordance with structural analysis.

c. In accordance with the fastener table printed in the appendix to this code.

2. a. Where the floor framing is parallel to the foundation wall, solid blocking or bridging shall be installed in at least the first adjacent joist space at a spacing of no more than 32 inches on center.

b. Solid blocking shall be of the same depth as the joist.

c. Fastening of the blocking or bridging shall be in accordance with structural analysis or the fastener table printed in the appendix to this code.

(e) Soil lateral load. Unless designed through structural analysis, soil lateral loads shall be determined from Table 21.18-A.

TABLE 21.18-A
SOIL LATERAL LOAD

Description of Backfill Material[e]	Unified Soil Classification	Design Lateral Soil Load[a] PSF per Foot of Depth
Well-graded, clean gravels; gravel-sand mixes	GW	30 [c]
Poorly graded clean gravels; gravel-sand mixes	GP	30 [c]
Silty gravels, poorly graded gravel-sand mixes	GM	40 [c]
Clayey gravels, poorly graded gravel-and-clay mixes	GC	45 [c]
Well-graded, clean sands; gravelly sand mixes	SW	30 [c]
Poorly graded clean sands; sand-gravel mixes	SP	30 [c]
Silty sands, poorly graded sand-silt mixes	SM	45 [c]
Sand-silt clay mix with plastic fines	SM-SC	45 [d]
Clayey sands, poorly graded sand-clay mixes	SC	60 [d]
Inorganic silts and clayey silts	ML	45 [d]
Mixture of inorganic silt and clay	ML-CL	60 [d]
Inorganic clays of low to medium plasticity	CL	60 [d]
Organic silts and silt clays, low plasticity	OL	[b]
Inorganic clayey silts, elastic silts	MH	60 [d]
Inorganic clays of high plasticity	CH	[b]
Organic clays and silty clays	OH	[b]

a. Design lateral soil loads are given for moist conditions for the specified soils at their optimum densities. Actual field conditions shall govern. Submerged or saturated soil pressures shall include the weight of the buoyant soil plus the hydrostatic loads.

b. Unsuitable as backfill material.

c. For relatively rigid walls, as when braced by floors, the design lateral soil load shall be increased for sand and gravel type soils to 60 psf per foot of depth. Basement walls extending not more than 8 feet below grade and supporting flexible floor systems are not considered relatively rigid walls.

d. For relatively rigid walls, as when braced by floors, the design lateral load shall be increased for silt and clay type soils to 100 psf per foot of depth. Basement walls extending not more than 8 feet below grade and supporting flexible floor systems are not considered relatively rigid walls.

e. Soil classes are in accordance with the Unified Soil Classification System, ASTM D2487, and design lateral loads are for moist soil conditions without hydrostatic pressure.

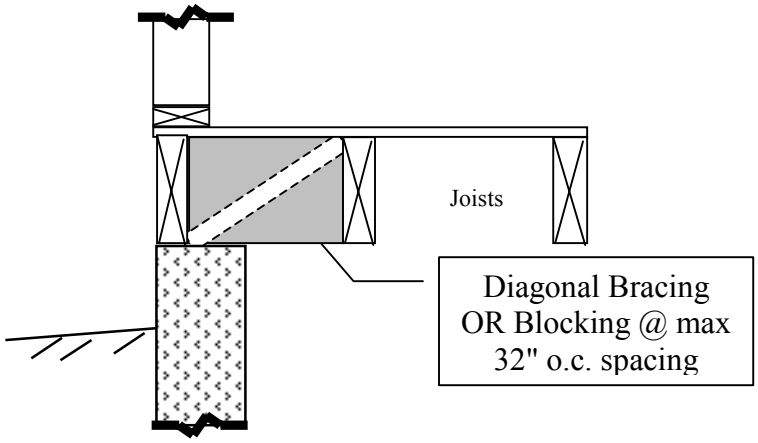
Foundation Wall Lateral Support

Question: *Why is lateral restraint required for foundation walls?*
Answer: *All of the UDC concrete and masonry foundation wall tables are based upon the assumption of lateral support at both the base and top of the walls.*

The base of the wall typically is restrained by the floor slab or the footing by a keyed joint or rebar. The top edge of the foundation wall may be restrained by the first floor through mechanical fastening or ledger blocking. (Ledger

blocking alone will not satisfy the dwelling anchorage requirement of s. 21.02(1)).

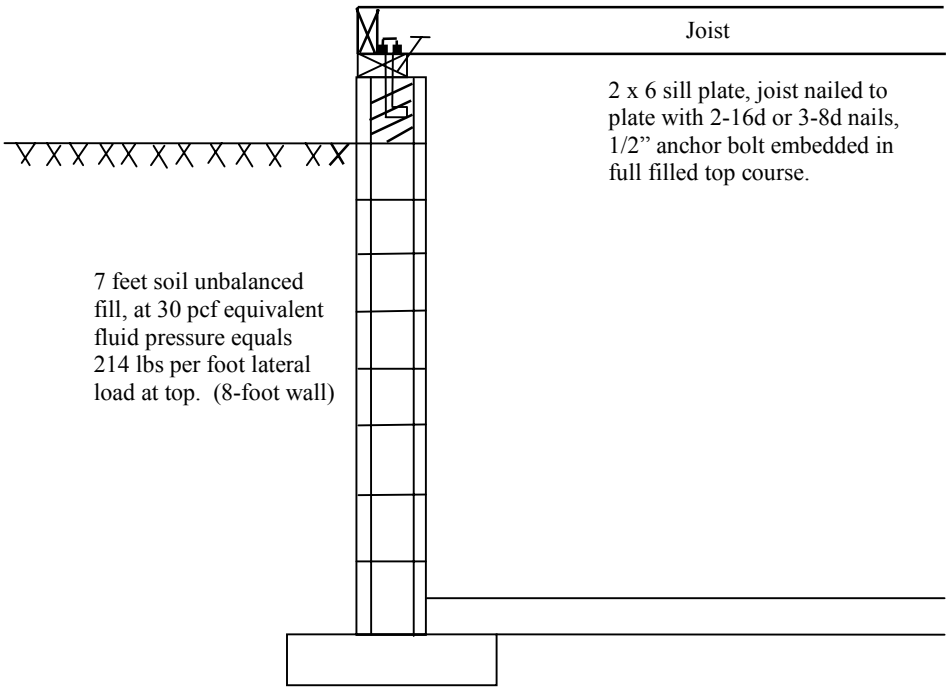
Section 21.18(1)(d)2.a. (1m) requires that lateral restraint shall be continuous from the wall to the plate to the restraining floor system. This may require that solid bridging or blocking be installed between the rim joist and adjacent floor joist that run parallel to the foundation wall to transfer the loads on the wall.



Another method would be to furr the inside of the foundation wall with 2 x 4s or an engineered system secured to the joists and bearing against the foundation wall or foundation wall footing.

A special case arises where the fill around a foundation is uneven, as in a walkout basement. In this case the soil pressure on either side of the house is not balanced, thereby possibly causing lateral racking movement of the foundation and floor system. To resist this, additional lateral support by rigid (plywood sheathed) interior cross walls or by pilasters may be needed.

FOUNDATION LATERAL RESTRAINT



In addition to bolts, other means such as straps or engineered connections may be used to provide lateral restraint to the top of the foundation wall.

(2) CONCRETE FOUNDATION WALLS. (a) Except as provided in par. (b), unless designed through structural analysis, the minimum thickness of concrete foundation walls shall be determined from Table 21.18-B, but in no case shall the thickness of the foundation wall be less than the thickness of the wall it supports.

(b) A 6-inch nominal wall thickness may be used provided the fill on one side of the wall is within 12 inches vertically of the fill on the other side of the wall.

TABLE 21.18-B

CONCRETE WALL THICKNESSES

Type of Concrete	Nominal Thickness (inches)	Maximum Height of Unbalanced Fill[1] for Material of Wall Being Supported (Wood frame - feet)
3000 psi		
Unreinforced concrete	8	8
	10	9
	12[2]	10
	14	11.5

[1] Unbalanced fill is the difference in elevation between the outside grade and the basement floor.

[2] The maximum height of unbalanced fill for a 12-inch thick plain concrete wall may be increased to 12 feet provided the wall is constructed of concrete with a minimum compressive value of 6,000 psi at 28 days.

Concrete Foundation Walls

Question: *Is a 6-inch thick concrete foundation wall acceptable for supporting a 2 x 6 frame wall? The thickness of the frame wall with sheathing, siding, and drywall will exceed the 6-inch foundation wall thickness.*

Answer: *"In no case shall the thickness of the foundation wall be less than the thickness of the wall it supports." This requirement refers to the width of the structural members of the supported wall. In the wall in question, only the 2 x 6 framing (5.5 inches) are considered structural supporting members, therefore the proposed wall is acceptable.*

Question: *Are there situations where the department will allow unreinforced concrete supporting walls thinner than specified in Table 21.18-A?*

Answer: *Yes, the department will allow 6-inch unreinforced concrete walls to be used provided the fill is within 12 inches of being evenly balanced on both sides of the wall. The top of any concrete slab and the finish grade is used to determine this measurement, such as in an attached garage situation or slab-on-grade dwelling.*

Table 21.18-A was developed to assist in determining the maximum height of unbalanced fill that may be placed against a basement wall. The Uniform Dwelling Code has never dealt directly with the issue of wall thickness where the fill is balanced on both sides. During a recent code update cycle, the entry in the table for 6-inch walls was deleted because the American Concrete Institute no longer allows unreinforced foundation walls or exterior basement walls less than 7.5 inches thick. However, section 7.1.6.2 of ACI 318.1-1989 allows bearing walls to be a minimum of 5.5 inches thick. With the fill balanced to within the 12-inch condition imposed above, the wall will be considered a bearing wall rather than a foundation or exterior basement wall. A 12-inch variation will still allow flexibility in grading without necessarily mandating the preservation of wall structural members.

Question: *What strength of concrete is a five-bag mix?*

Answer: *The strength of concrete is dependent upon a number of factors including the cement-water ratio involved in the mix. A five-bag mix means that 470 lbs. of cement is used per cubic yard of concrete. Without knowing how much water is also used per cubic yard of concrete, the actual design strength of the concrete cannot be determined. Concrete suppliers should have their design mixes tested prior to field use per the American Concrete Institute (ACI) specifications. (See following section.)*

Concrete Foundation Walls (Concrete Quality)

Compressive Strength of Concrete

The average strength of concrete produced must always exceed the specified value of concrete strength (f'_c) that was used in the structural design phase. This is based on probabilistic concepts, and is intended to ensure that adequate strength will be developed in the structure.

Acceptable Practice for Concrete Design

The specified strength of concrete for foundations and footings in one- and two-family dwellings shall be at least 2,500 PSI per s. 4.2 of ACI 318.1-89, Plain Concrete Code. The height of 3,000 psi concrete foundation walls shall be governed by Table 21.18-A or alternately, for greater or lesser concrete stengths, through engineered design. Table 21.18-A assumes the wall has lateral support at both top and bottom.

Proportioning on the Basis of Field Experience

For establishing concrete proportions, emphasis is placed on the use of laboratory trial batches or field experience as the basis for selecting the required water/cement ratio. If an applicable standard deviation for strength tests of the concrete is known, this establishes the target strength level from which the concrete must be proportioned. Otherwise, the proportions must be selected to produce an excess of target strength sufficient to allow for a high degree of variability in the strength tests.

Where the concrete production facility has a record based on at least 30 consecutive strength tests representing similar materials and conditions to those expected, the strength used as the basis for selecting proportions shall exceed the required specified strength of concrete (f'_c) by at least:

TABLE A. REQUIRED OVERDESIGN

Standard Deviation (psi)	*Required Average (psi)*
Under 300	$f'_c + 400$
300 - 400	$f'_c + 550$
400 - 500	$f'_c + 700$
500 - 600	$f'_c + 900$
Over 600	$f'_c + 1200$
Unknown	$f'_c + 1200$

The indicated average strength levels are intended to reduce the probability of concrete strength being questioned on any of the following usual bases: (1) too many tests below specified f'c; (2) strength averaging below specified f' for an appreciable period (three

consecutive tests); or (3) an individual test being disturbingly low (more than 500 psi below specified f''c).

Proportioning on Basis of Acceptable Practice

If test data is not available, the following water/cement weight ratio may be used to determine acceptable concrete strength.

3000 PSI concrete use .58 water/cement ratio

The following tables give guidelines for proportioning a mix of 1 cubic yard to develop acceptable strength levels. Recommended slump for footings, foundation and slabs is between 1 and 3 inches.

TABLE C APPROXIMATE MIX FOR SLUMP OF 1-2 INCHES

Size Aggregate	*Water Lbs.*	*Gallons*	*3000 PSI LB. of Cement*	*94# Bags*	*Percent* Volume of Coarse Aggregate*
1/2"	*335*	*40*	*578*	*6.2*	*50-60*
1"	*300*	*36*	*517*	*5.5*	*64-72*
1 1/2"	*275*	*33*	*474*	*5.0*	*68-76*
2"	*260*	*31*	*448*	*4.8*	*71-79*

TABLE D APPROXIMATE MIX FOR SLUMP OF 3-4 INCHES

Size Aggregate	*Water Lbs.*	*Gallons*	*3000 PSI LB. of Cement*	*94# Bags*	*Percent* Volume of Coarse Aggregate*
1/2"	*365*	*44*	*629*	*6.7*	*50-60*
1"	*325*	*39*	*560*	*6.0*	*64-72*
1 1/2"	300	*36*	517	*5.5*	*68-76*
2"	*285*	*34*	508	*5.4*	*71-79*

**Percent of coarse aggregate will vary with different fineness moduli of sand.*

(3) MASONRY FOUNDATION WALLS. (a) Dampproofing. Masonry foundation walls shall be dampproofed by applying to the exterior surface from footing to finished grade, a continuous coating of one of the following:

1. Portland cement and sand coat mortar, at least 3/8 inch thick.

2. Type M or S mortar, at least 3/8 inch thick.

3. Structural surface bonding material, at least 1/4 inch thick.

4. Equivalent dampproofing material, applied in accordance with the manufacturer's instructions and acceptable to the department.

(b) Structural requirements. Unless designed through structural analysis, the masonry foundation walls shall be constructed in accordance with ACI 530.1 and the following requirements:

1. The minimum thickness of unreinforced masonry foundation walls shall be determined by Table 21.18-C, but in no case shall the thickness be less than the thickness of the wall it supports.

2. Reinforced masonry walls shall be reinforced in accordance with the requirements of Tables 21.18-D, 21.18-E or 21.18-F. Vertical reinforcement shall be provided on each side of any opening and at intervals indicated in the appropriate table.

3. Vertical reinforcement shall have a minimum yield strength of 60,000 psi.

4. Solid-grouted hollow units or cores containing vertical reinforcement shall be filled with masonry grout that complies with ASTM C 476.

5. In lieu of the reinforcement provisions of Tables 21.18-D, 21.18-E and 21.18-F, alternative reinforcing bar size and spacing having an equivalent cross-sectional area or reinforcement per linear foot of wall is permitted, provided the spacing of the reinforcement does not exceed 72 inches and reinforcing bar size does not exceed No. 11.

6. The depth below grade, wall height and reinforcement spacing may exceed the maximum values indicated in Tables 21.18-D, 21.18-E and 21.18-F only if the design is based on structural analysis.

Dampproofing

Question: *Could you clarify the UDC requirements for waterproofing of poured concrete foundation walls?*

Answer: *This section only specifically requires waterproofing of masonry foundation walls. Section Comm 20.24 (2) adopts American Concrete Institute's Standards ACI 318-83 and ACI 318.1-83 for reinforced and plain concrete. Neither of these standards mention waterproofing requirements. In summary, there are no requirements for waterproofing of poured concrete walls in new one- and two-family dwelling construction.*

Question: *The footings and concrete block foundation of a house will be located in a clay-type soil with the foundation wall being insulated on the exterior from the footing to the top. Does the foundation wall have to be dampproofed before the insulation is applied?*

Answer: *Yes, this section requires dampproofing of masonry foundation walls of basements in clay-type soils with a continuous coat of at least 3/8-inch thick portland cement and sand coat mortar, a type M mortar troweled smooth, or 1/4-inch bonding materials applied to the exterior surfaces. The exterior applied insulation may then be installed.*

Table 21.18-C
PLAIN MASONRY FOUNDATION WALLS [d]

Maximum Wall Height (ft - in)	Depth of unbalanced backfill height (ft)	Minimum nominal wall thickness (inches)		
		Soil classes and lateral soil load[a] (psf per foot of depth)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, MH, ML-CL and inorganic CL soils 60
7 - 0 7 - 8	4 (or less)	8	8	8
	5	8	10	10
	6	10	12	10 (solid[b])
	7	12	10 (solid[b])	12 (solid[b])
8 - 4	4 (or less)	8	8	8
	5	8	10	12
	6	10	12	12 (solid[b])
	7	12	12 (solid[b])	Note c
	8	10 (solid[b])	12 (solid[b])	Note c
9 - 1	4 (or less)	8	8	8
	5	8	10	12
	6	12	12	12 (solid[b])
	7	12 (solid[b])	12 (solid[b])	Note c
	8	12 (solid[b])	Note c	Note c
	9	Note c	Note c	Note c

a. For design lateral soils and descriptions of soil classes, see s. Comm 21.18(1)(d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Solid grouted hollow units.

c. An analysis in compliance with ACI 530 or reinforcement in accordance with Table 21.18-D, 21.18-E or 21.18-F is required.

d. Mortar shall be Type M or S and masonry shall be laid in running bond.

TABLE 21.18-D [b,c,d]
8, 10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 5 in.[e]

Maximum Wall Height (ft - in)	Height of unbalanced backfill (ft)	Vertical reinforcement		
		Soil classes and lateral soil load[a] (psf per foot of depth)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, MH, ML-CL and inorganic CL soils 60
7 – 0	4 (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
7 – 8	5	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 40" o.c.
	6	#4 at 48" o.c.	#5 at 48" o.c.	#5 at 40" o.c.
	7	#4 at 40" o.c.	#5 at 40" o.c.	#6 at 48" o.c.
8 - 4	4 (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 40" o.c.
	6	#4 at 48" o.c.	#5 at 48" o.c.	#5 at 40" o.c.
	7	#5 at 48" o.c.	#6 at 48" o.c.	#6 at 40" o.c.
	8	#5 at 40" o.c.	#6 at 40" o.c.	#7 at 40" o.c.
9 - 1	4 (or less)	#4 at 48" o.c.	#4 at 48" o.c.	#4 at 48" o.c.
	5	#4 at 48" o.c.	#4 at 48" o.c.	#5 at 48" o.c.
	6	#4 at 48" o.c.	#5 at 48"o.c.	#6 at 48" o.c.
	7	#5 at 48" o.c.	#6 at 48" o.c.	#7 at 48" o.c.
	8	#5 at 40" o.c.	#7 at 48" o.c.	#8 at 48" o.c.
	9	#6 at 40" o.c.	#8 at 48" o.c.	#8 at 32" o.c.

a. For design lateral soil loads, see s. Comm 21.18(1)(d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).

c. For alternative reinforcement, see s. Comm 21.18 (3) (b).

d. Mortar shall be Type M or S and masonry shall be laid in running bond.

e. The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

TABLE 21.18-E [b,c,d]
10 OR 12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 6.75 in.[e]

REINFORCED MASONRY				
Maximum Wall Height (ft – in)	Height of unbalanced backfill (ft)	Vertical reinforcement		
		Soil classes and lateral soil load[a] (psf per foot below natural grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, MH, ML-CL and inorganic CL soils 60
7 – 0	4 (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
7 – 8	5	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	6	#4 at 56" o.c.	#4 at 48" o.c.	#4 at 40" o.c.
	7	#4 at 56" o.c.	#5 at 56" o.c.	#5 at 40" o.c.
8 – 4	4 (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 48" o.c.
	6	#4 at 56" o.c.	#4 at 48" o.c.	#5 at 56" o.c.
	7	#4 at 48" o.c.	#4 at 32" o.c.	#6 at 56" o.c.
	8	#5 at 56" o.c.	#5 at 40" o.c.	#7 at 56" o.c.
9 – 1	4 (or less)	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 56" o.c.
	5	#4 at 56" o.c.	#4 at 56" o.c.	#4 at 48" o.c.
	6	#4 at 56" o.c.	#4 at 40" o.c.	#4 at 32" o.c.
	7	#4 at 40" o.c.	#5 at 48" o.c.	#6 at 48" o.c.
	8	#4 at 32" o.c.	#6 at 48" o.c.	#4 at 16" o.c.
	9	#5 at 40" o.c.	#6 at 40" o.c.	#7 at 40" o.c.

a. For design lateral soil loads, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).

c. For alternative reinforcement, see s. Comm 21.18 (3) (b).

d. Mortar shall be Type M or S and masonry shall be laid in running bond.

e. The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

TABLE 21.18-F [b,c,d]
12 IN. REINFORCED MASONRY FOUNDATION WALLS WHERE d ≥ 8.75 in.[e]

REINFORCED MASONRY				
Maximum Wall Height (ft - in)	Height of unbalanced backfill (ft)	Vertical reinforcement		
		Soil classes and lateral soil load[a] (psf per foot below natural grade)		
		GW, GP, SW and SP soils 30	GM, GC, SM, SM-SC and ML soils 45	SC, MH, ML-CL and inorganic CL soils 60
7 – 0	4 (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
7 – 8	5	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6	#4 at 72" o.c.	#4 at 64" o.c.	#4 at 48" o.c.
	7	#4 at 72" o.c.	#4 at 48" o.c.	#5 at 56" o.c.
8 – 4	4 (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	6	#4 at 72" o.c.	#4 at 56" o.c.	#5 at 72" o.c.
	7	#4 at 64" o.c.	#5 at 64" o.c.	#4 at 32" o.c.
	8	#4 at 48" o.c.	#4 at 32" o.c.	#5 at 40" o.c.
9 – 1	4 (or less)	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 72" o.c.
	5	#4 at 72" o.c.	#4 at 72" o.c.	#4 at 64" o.c.
	6	#4 at 72" o.c.	#4 at 56" o.c.	#5 at 64" o.c.
	7	#4 at 56" o.c.	#4 at 40" o.c.	#6 at 64" o.c.
	8	#4 at 40" o.c.	#6 at 64" o.c.	#6 at 48" o.c.
	9	#5 at 56" o.c.	#7 at 72" o.c.	#6 at 40" o.c.

a. For design lateral soil loads, see s. Comm 21.18 (1) (d). Soil classes are in accordance with the Unified Soil Classification System and design lateral soil loads are for moist soil conditions without hydrostatic pressure.

b. Provisions for this table are based on construction requirements specified in s. Comm 21.18 (3) (b).

c. For alternative reinforcement, see s. Comm 21.18 (3) (b).

d. Mortar shall be Type M or S and masonry shall be laid in running bond.

e. The specified location of the reinforcement shall equal or exceed the effective depth distance, d, measured from the face of the soil side of the wall to the center of vertical reinforcement.

Masonry Foundation Walls

In addition to Tables 21.18-B, C, D, designers may use two alternative methods of designing masonry walls.

1. *Builder may design a reinforced wall design using structural analysis per s. Comm 21.18(2) and s. Comm 21.02(3)(e) "Concrete Masonry Handbook" or other accepted engineering standard.*

2. *Builder may design using s. Comm 53.322 of the Commercial Building Code as an engineering standard. This "Empirical Method of Design" could be used as a structural design aid per s. Comm 21.18(2).*

(4) WOOD FOUNDATIONS. Wood foundations shall be designed and constructed in accordance with "The Permanent Wood Foundation System, Basic Requirements, Technical Report No. 7," as adopted under s. Comm 20.24, Table 20.24-2 and the following exception. The thickness of the foundation wall shall be no less than the thickness of the wall it supports.

(a) Exception. Section 3.3.1. Fasteners. Fasteners shall be of silicon bronze, copper or stainless steel types 304 or 316.

Note: Additional explanatory information regarding wood foundations can be obtained in "All-Weather Wood Foundation Systems, Design, Fabrication, Installation Manual," published by the National Forest Products Association.

(b) Materials. All lumber and plywood shall be pressure treated with preservative and labeled to show conformance with AWPA C-22.

Wood Foundations

A copy of The Permanent Wood Foundation System, Basic Requirements, Technical Report No. 7 may be obtained from the:

American Forest & Paper Association
1111 19th Street, NW
Suite 800
Washington, DC 20036
(202) 463-2700 · info@afandpa.org

The overview which follows is meant as an introduction to the system. Inspectors and designers are urged to obtain a copy of Technical Report No. 7 before inspecting or designing wood foundations.

Part l. General Description

The Permanent Wood Foundation (PWF) system was developed cooperatively between the wood products industry and the U.S. Forest Service. The system is recognized by all national model codes.

The general framing assembly is similar to above-grade wall construction except for three features:

l. Framing, sheathing and footer plates are designed to resist lateral soil loads in addition to vertical loads which control most above-grade wall design.

2. All material is preservative treated and fasteners are corrosion resistant.

3. *Soil drainage and exterior waterproofing are integral to the performance of the wall system. Without these features, soil water pressures and presence could result in failure.*

Part 2. Scope
The Technical Report is developed for adoption by code-enforcing authorities. It in turn adopts national standards regarding preservative treatment, fastener, NDS, plywood specifications, etc.

Another manual entitled the "Permanent Wood Foundation System Design, Fabrication, Installation Manual" is also available from NFPA. This manual is helpful as a design tool and includes structural tables and construction details.

Part 3. Materials

As in s. Comm 21.02 (and the NDS), all lumber and plywood should be grade or span rating stamped to identify its structural properties.

Per s. Comm 21.18(3)(a), fasteners shall be of silicon bronze, copper or stainless steel materials for use in preservative treated wood installed below grade. Hot dipped zinc coated steel nails may be used in preservative treated wood installed above grade and in some below-grade locations not subject to soil contact.

Electrogalvanized nails, staples, hot dipped zinc, or other zinc coated staples are not permitted.

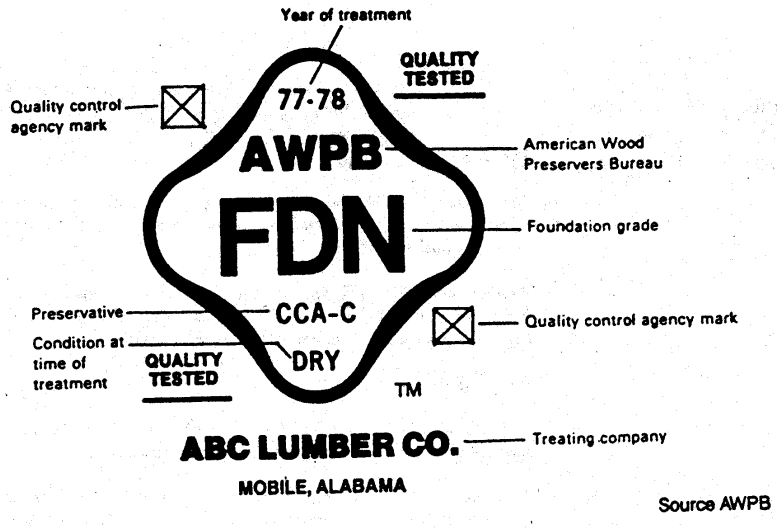
Framing anchors shall be of zinc coated sheet steel. Nails used to install framing anchors shall meet the above fastener requirements.

Materials used for footings or fill shall consist of gravel, coarse sand or crushed stone. Such materials should be free of organic, clayey or silty soils.

Polyethylene sheeting must be suitable for construction, industrial or agricultural applications. Typically a six-mil thickness is required.

Bonding sealants and caulking shall be suitable for the materials, temperature and moisture conditions encountered. This applies to plywood-to-plywood, plywood-to-plastic and plastic-to-plastic joints.

Part 4. Preservative Treatment
All lumber and plywood shall be preservative treated and stamped AWPB-FDN (Alternately, AWPA Standard C-22) with a preservative retention rate of .60 pounds per cubic foot of wood. The FDN suffix indicates it is allowable for wood foundation use. See following diagram.



Before such material is installed, it must be dried to a maximum l9 percent moisture content. This is important to prevent shrinkage after assembly. It also recognizes that structural strength is reduced at high moisture contents.

If AWPB-FDN lumber is cut or drilled, the cut surface must be field treated with a preservative.

Preservative treated wood is required for all foundation wall material in the ground or in contact with concrete. Some members that do not require treatment include the upper top plate, window or door headers or portions of foundation walls in walkout basements. All material within 8 inches above finished grade must be AWPB-FDN treated.

Part 5. Soil Characteristics

For the purpose of wood foundation design requirements, soils are classified into four groups:

Group l - Good drainage

Example: sands, gravels, silty gravels, silty sands

Group 2 - Medium drainage

Example: clayey gravels, clayey sands slightly to medium plasticity inorganic clays and silts (i.e., stiff or firm clays or silts)

Group 3 - Poor drainage

Example: highly plastic clays, very fine sands or silts

Group 4 - Unsatisfactory drainage

Example: organic silts and clays; peat and other organic soils

Group 4 soils are unsatisfactory for wood foundation (or other foundations per s. Comm 21.15(2)(b)) unless designed by a soils engineer.

Part 6. Environmental Control

To maintain a dry foundation wall and basement, additional drainage and waterproofing measures must be taken over and above the UDC minimums for other types of foundation walls.

A few key points to consider:

l. A drain tile system per s. Comm 21.17 is not necessarily required. The standard wood basement foundation design (in Group I, II or III soils) requires an "envelope" of gravel, crushed stone or sand porous fill about the foundation walls and basement floor. This envelope involves 4 inches of porous fill under the basement floor and footing plate (6 inches for Group III soils). Porous fill should also be used to backfill the excavation-basement wall trench for half the height of the excavation.

2. This drainage envelope shall be served by a sump system similar to s. Comm 21.17(3) and (4). However, the porous fill envelope is designed to fill the sump without the mandatory use of a drain tile system.

3. The porous fill under the foundation wall acts as the footing for the wall. As an alternative, a concrete footer may be used. If so, bleeders must be installed every 6 feet along the perimeter to ensure soil water along the foundation wall can be easily transmitted to the underslab drainage material and then into the sump.

4. Waterproofing of the foundation wall is accomplished by a combination of sealing and installation of a waterproof membrane. All plywood panel joints are to be caulked. Polyethylene sheeting must be installed continuously over the height of the below-grade wall. All plastic-to-plastic and plastic-to-wood joints shall be lapped and sealed (caulked). A protective treated plywood or equivalent strip shall cover any poly sheeting exposed at grade to guard against damage caused by exposure to light or physical forces.

5. Polyethylene sheeting is also required between the basement floor and the fill below.

<u>Part 7. Design Loads</u>
The design loads in s. Comm 21.01 apply for determining the vertical load from the dwelling which the foundation supports.

Lateral soil loads are assumed equivalent to a 30 pound per cubic foot fluid pressure against the foundation walls. Unstable Group III soils and Group IV soils would require a soil engineer to determine lateral soil load.

<u>Part 8. Structural Design</u>
Structural design shall conform to the National Design Specification (NDS) as adopted by s. Comm 21.02(3). Also, plywood panels shall conform to the load tables in the "Plywood Design Specification" by APA.

The wood foundation structural design can be broken down into three aspects: the footing, foundation wall and the lateral support system.

The typical wood foundation wall footing consists of a composite wood footer plate and a gravel, stone or sand porous footing bed. The foundation wall base plate distributes vertical load to 2 x lumber footer plate which distributes load to the porous bed which then distributes the load to the soil below. All three components must be designed to support the load/pressures encountered. That is, the footer plate allowable stresses, the porous bed (sand, stone, gravel) or natural soil allowable pressures, should not be exceeded per the NDS or s. Comm 21.15(2).

The foundation wall itself differs from the typical masonry or concrete wall in that two separate components, the plywood and studs, must be designed to support their respective loadings. Plywood panels must conform to APA design tables. Wood studs (typically 2 x 6, 2 x 8) must conform to NDS design standards.

Besides lateral and axial loads, some walls shall be designed for racking loads. Racking loads act in the plane of the wall, in the direction of the wall length. Such loads may be caused by differential soil pressure (uneven backfill heights against the building) wind or earthquake. Buildings with walkout basements should be designed with adequate shear strength in the wall to resist racking loads.

Interior load bearing walls in such buildings shall be designed per s. Comm 21.25.

A lateral support system must be provided to brace the foundation walls against lateral soil and racking loads. This is done by anchoring the top of the wall to the floor system. The base of the wall is held in place by the basement floor. In crawl spaces without floors, at least 6 inches of soil must be provided against the inside of the wall to provide lateral support.

Where walls are parallel to floor joists (end walls) blocking shall be provided to transfer lateral load from the top plate/rim joist to the floor system.

Tables in the Appendix to Technical Report No. 7 provide structural design information for wall studs, sheathing and fasteners. Recommendations are also provided for shear wall design to resist racking loads.

Subchapter VI — Floors

Comm 21.19 Floor design.

Floors shall support all dead loads plus the minimum unit live loads as set forth in s. Comm 21.02. The live loads shall be applied to act vertically and uniformly to each square foot of horizontal floor area. Basements shall be provided with wood or concrete or similar type floors that comply with s. Comm 21.20 or 21.205.

Comm 21.20 Concrete floors.

(1) When concrete floors are provided, the thickness of the concrete shall measure at least 3 inches.

(2) When a concrete floor is placed in clay soils, a 4-inch thick base course shall be placed in the subgrade consisting of clean graded sand, gravel or crushed stone.

(3) When a concrete floor is placed on sand or gravel soils, the base course may be omitted unless drain tile is installed. If drain tile is installed, the requirements of s. Comm 21.17 shall be met.

Comm 21.203 Garage floors.

(1) MATERIALS. Garage floors shall be constructed of concrete or other noncombustible materials which are impermeable to petroleum products. Slab-on-grade concrete garage floors shall be at least 4 inches thick and placed over at least 4 inches of granular fill.

Note: It is not the intent of sub. (1) to require a concrete floor to be sealed to make it completely impermeable.

(2) CONFIGURATION. The floor shall be sloped such that water is removed in accordance with one of the following:

(a) Water drains toward the overhead door or to exterior grade such that no damage will be caused to any structural member or wall cvoering of the garage or the dwelling.

(b) Water drains into an interior floor drain that complies with the requirements of ch. Comm 82.

Note: See s. Comm 82.34, Uniform Plumbing Code, for floor drain requirements.

Question: *Can the garage floor be at the same elevation as the finished floor of the dwelling or is a step or landing required in the garage at a door between the two?*

Answer: *The code doesn't require an elevation change between the garage floor and the dwelling floor, only that the garage floor slope to the main exterior opening or floor drain.*

Question: *What is the minimum pitch of the garage floor?*

Answer: *The code is silent on this and doesn't prescribe the degree of pitch, only that it must have a slope to provide drainage. An suggested rule of thumb for concrete flat work is 1/8 inch drop per foot of run.*

Comm 21.205 Wood floors in contact with the ground.

Wood floors in contact with ground shall comply with the requirements under s. Comm 21.18 (4).

These floors would also have to comply with Comm 21.10 (1), (2), and (3).

Comm 21.21 Precast concrete floors.

Precast concrete floors shall be designed through structural analysis, or load tables furnished by the precast product fabricator may be used, provided the load tables were developed using structural analysis or load testing.

Comm 21.22 Wood frame floors.

Unless designed through structural analysis, wood frame floors shall comply with the following requirements:

(1) FLOOR JOISTS. Wood floor joists shall comply with the requirements of s. Comm 21.02 (3) (a). The minimum live loads shall be determined from s. Comm 21.02. Where sill plates are provided, the sill plates shall be fastened to the foundation. Double floor joists shall be provided underneath all bearing walls which are parallel to the floor joists.

Floor Joist Design

Question: *Does the deflection of floor joists have to be limited to the L/360 as shown in the upper left corner of Table J-1 found in the code appendix.*

Answer: *There is no requirement in ch. Comm 21 stating what the maximum deflection of structural members must be. Deflection would, therefore, be controlled indirectly through accepted engineering practice. Also, there is no rule in Ch. Comm 21 which specifically states that deflection in Table J-1 is part of the rule. All appendix tables are deemed to meet the minimum standards.*

(1m) FLOOR JOISTS ON MASONRY WALLS. (a) On masonry walls, the floor joists shall rest upon one of the following:

1. A mortar-filled or grout-filled core masonry block.

2. A solid-top masonry block.

3. A sill plate at least as wide as the nominal width of the wall.

Note: See s. Comm 21.10 (4) for treatment requirements for wood in contact with masonry.

Floor Joists and Sill Plates

Question: *A wood floor joist system is resting on a sill plate which in turn rests on a hollow concrete masonry foundation. Does the top course of masonry need to have all cores and joints filled with mortar?*

Answer: *Per s. Comm 21.22(1m), the cores of the blocks need not be filled as long as a sill plate is as wide as the block itself is used. If a sill plate is smaller then the width of the block or if a sill plate is not used, then all the cores must be filled.*

(2) FLOOR TRUSSES. Metal plate connected wood floor trusses shall be designed in accordance with the Design Specifications for Metal Plate Connected Parallel Chord Wood Trusses and the National Design Specification for Wood Construction. Truss members shall not be cut, bored or notched.

(3) GIRDERS AND BEAMS. Girders and beams shall be selected from Table 21.22-A1 or Table 21.22-A2 or shall be designed through structural analysis.

(a) Wood girders and beams shall be fitted at the post or column. Adjoining ends shall be fastened to each other to transfer horizontal loads across the joint. Beams shall also be fastened to the posts with framing anchors, angle clips, or equivalent.

(b) Where intermediate beams are used, they shall rest on top of the girders; or shall be supported by ledgers or blocks fastened to the sides of the girders; or they may be supported by approved metal hangers into which the ends of the beams shall be fitted.

TABLE 21.22-A1

MINIMUM SIZES FOR BEAMS AND GIRDERS OF STEEL OR WOOD

	One Floor Only		Roof/Ceiling and One Floor				Roof/Ceiling + One Floor/Ceiling + One Floor			
			Wood Beams[1,3] (in., nominal)		A 36 Steel Beams[2]		Wood Beams[1,3] (in., nominal)		A 36 Steel Beams[2]	
Column Spacing	Wood Beams[1] (in., nominal)	A 36 Steel Beams[2]	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1
24 ft. wide house:										
8 ft.	8x8	---	8x10	10x10	---	---	8x12	10x12	---	---
			6x12	6x12	---	---	6x14	8x14	---	---
10 ft.	8x10	---	8x12	10x12	M 10x9	M 10x9	10x14	10x14	M 12x11.8	M 12x11.8
			6x14	8x14	W 6x12	W 8x10	8x16	8x16	W 8x15	W 8x15
12 ft.	8x12	---	12x12	10x14	M 12x10	M 12x11.8	14x14	14x14	W 12x16	W 12x16
			10x14	8x16	W 10x11.5	W 8x15	10x16	12x16	W 10x17	W 8x21
15 ft.	12x12	---	---	---	W 12x16	W 12x16	---	---	W 12x22	W 14x22
			---	---	W 10x17	W 6x25	---	---	W 8x28	W 8x31
26 ft. wide house:										
8 ft.	6x10	---	10x10	10x10	---	---	10x12	10x12	---	---
			6x12	8x12	---	---	8x14	8x14	---	---
10 ft.	10x10	---	10x12	10x12	M 10x9	M 12x10	10x14	12x14	M 12x11.8	W 12x14
			8x14	8x14	W 8x10	W 8x13	8x16	8x16	W 8x15	W 8x17
12 ft.	8x12	---	10x14	10x14	M 12x11.8	M 12x11.8	14x14	12x16	W 12x16	W 10.19

			8x16	8x16	W 8x15	W 6x20	12x16	10x18	W 8x21	W 8x24
15 ft.	10x14	---	---	---	W 12x16	W 10x19	---	---	W 14x22	W 14x22
			---	---	W 8x21	W 8x24	---	---	W 8x31	W 8x35
28 ft. wide house:										
8 ft.	6x10	---	10x10	8x12	---	---	10x12	10x12	---	---
		---	8x12	4x16	---	---	8x14	8x14	---	---
10 ft.	10x10	M 10x7.5	10x12	12x12	M 12x10	W 10x12	12x14	12x14	W 12x14	W 12x14
		W 6x9	8x14	8x14	W 8x13	W 8x13	8x16	10x16	W 8x17	W 10x15
12 ft.	10x12	M 10x9	10x14	12x14	M 12x11.8	W 12x14	12x16	12x16	W 10x19	M 14x18
		W 6x12	8x16	10x16	W 8x15	W 8x18	10x18	10x18	W 8x24	W 8x24
15 ft.	10x14	M 12x10	---	---	W 10x19	M 14x18	---	---	W 14x22	W 14x26
		W 8x13	---	---	W 8x24	W 8x24	---	---	W 8x35	W 8x35

TABLE 21.22-A1

MINIMUM SIZES FOR BEAMS AND GIRDERS OF STEEL OR WOOD

	One Floor Only		Roof/Ceiling and One Floor				Roof/Ceiling + One Floor/Ceiling + One Floor			
			Wood Beams[1] (in., nominal)		A 36 Steel Beams[2]		Wood Beams[1] (in., nominal)		A 36 Steel Beams[2]	
Column Spacing	Wood Beams[1] (in., nominal)	A 36 Steel Beams[2]	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1	Zone 2	Zone 1
30 ft. wide house:										
8 ft.	8x10	---	10x10	8x12	---	---	10x12	12x12	---	---
			8x12	6x14	---	---	8x14	8x14	---	---
10ft.	10x10	M 10x7.5	10x12	12x12	M 12x10	M 12x10	12x14	12x14	W 12x14	W 12x14
		W 6x9	8x14	10x14	W 8x13	W 8x13	10x16	10x16	W 10x15	W 10x15
12 ft.	10x12	M 10x9	12x14	12x14	W 12x14	W 12x14	12x16	14x16	M 14x18	M 14x18
		W 6x12	8x16	10x16	W 8x18	W 8x18	10x18	12x18	W 8x24	W 8x24
15 ft.	12x14	M 12x11.8	---	---	M 14x18	W 10x21	---	---	W 14x26	W 14x26
		W 8x15	---	---	W 8x24	W 8x28	---	---	W 8x35	W 10x33
32 ft. wide house:										
8 ft.	8x10		8x12	8x12	---	---	12x12	12x12	---	---
			6x14	6x14	---	---	8x14	10x14	---	---
10 ft.	10x10	M 10x7.5	12x12	12x12	W 10x12	W 10x12	12x14	14x14	W 12x14	W 12x16
		W 6x9	8x14	10x14	W 8x13	W 6x16	10x16	10x16	W 10x15	W 10x17
12 ft.	10x12	M 10x9	12x14	14x14	W 12x14	W 12x14	14x16	14x16	M 14x18	M 12x22
		W 6x12	10x16	10x16	W 10x15	W 10x17	12x18	12x18	W 8x24	W 8x28
15 ft.	12x14	M 12x11.8	---	---	M 14x18	W 12x22	---	---	W 14x26	W 14x26
		W 8x15	---	---	W 8x24	W 8x28	---	---	W 10x33	W 10x33

1 This table is based upon wood with a fiber bending stress of 1,000 psi. Two acceptable wood beam selections are listed for each loading condition.

2 Two acceptable steel beam selections are listed for each loading condition. The first entry is the most economical selection based upon beam weight.

3 Wood main beams or girders may be built up from nominal 2-inch members. The 2-inch members shall be laid on edge and fastened together with a double row of common nails not less than 3 1/2 inches in length. Nails shall be spaced not more than 18 inches apart in each row with the end nails placed 4 inches to 6 inches from the end of each piece. Where built-up beams are employed over a single span, the length of each individual piece used to fabricate the beam shall equal the length of the beam.

TABLE 21.22-A2
MINIMUM SIZES FOR BUILT-UP WOOD BEAMS IN BASEMENTS AND CRAWLSPACES SUPPORTING ONE FLOOR ONLY

	Fb = 800 psi		Fb = 1000 psi		Fb = 1200 psi		Fb = 1400 psi	
House Width	Col. Spacing ft-in	Beam Size	Col. Spacing ft-in	Beam Size	Col. Spacing ft-in	Beam Size	Col. Spacing ft-in	Beam Size
16 ft.	7-8	3-2x8	8-7	3-2x8	9-4	3-2x8	10-2	3-2x8
	8-11	4-2x8	9-11	4-2x8	10-11	4-2x8	11-10	4-2x8
	9-11	3-2x10	11-1	3-2x10	12-1	3-2x10	13-1	3-2x10
	11-4	4-2x10	12-8	4-2x10	13-1	4-2x10	15-0	4-2x10
	12-0	3-2x12	13-5	3-2x12	14-8	3-2x12	15-10	3-2x12
	13-10	4-2x12	15-7	4-2x12	17-0	4-2x12	18-4	4-2x12
20 ft.	6-11	3-2x8	7-8	3-2x8	8-5	3-2x8	9-1	3-2x8
	7-11	4-2x8	8-11	4-2x8	9-9	4-2x8	10-7	4-2x8
	8-10	3-2x10	9-11	3-2x10	10-10	3-2x10	11-8	3-2x10
	10-2	4-2x10	11-4	4-2x10	12-6	4-2x10	13-6	4-2x10
	10-9	3-2x12	12-0	3-2x12	13-2	3-2x12	14-3	3-2x12
	11-5	4-2x12	13-11	4-2x12	15-2	4-2x12	16-5	4-2x12
24 ft.	6-3	3-2x8	7-1	3-2x8	7-8	3-2x8	8-4	3-2x8
	7-3	4-2x8	8-2	4-2x8	8-11	4-2x8	9-8	4-2x8
	8-1	3-2x10	9-0	3-2x10	9-11	3-2x10	10-8	3-2x10
	9-4	4-2x10	10-4	4-2x10	11-5	4-2x10	12-4	4-2x10
	9-9	3-2x12	10-11	3-2x12	12-0	3-2x12	12-11	3-2x12
	11-3	4-2x12	12-7	4-2x12	13-11	4-2x12	15-0	4-2x12
28 ft.	5-10	3-2x8	6-6	3-2x8	7-2	3-2x8	7-8	3-2x8
	6-8	4-2x8	7-6	4-2x8	8-3	4-2x8	8-11	4-2x8
	7-5	3-2x10	8-4	3-2x10	9-1	3-2x10	9-11	3-2x10
	8-7	4-2x10	9-8	4-2x10	10-6	4-2x10	11-4	4-2x10
	9-0	3-2x12	10-1	3-2x12	11-1	3-2x12	10-11	3-2x12
	10-5	4-2x12	11-8	4-2x12	12-10	4-2x12	13-10	4-2x12
32 ft.	5-4	3-2x8	6-1	3-2x8	6-8	3-2x8	7-3	3-2x8
	6-3	4-2x8	7-1	4-2x8	7-8	4-2x8	8-4	4-2x8
	7-0	3-2x10	7-9	3-2x10	8-7	3-2x10	9-2	3-2x10
	8-1	4-2x10	8-11	4-2x10	9-10	4-2x10	10-8	4-2x10
	8-5	3-2x12	9-6	3-2x12	10-4	3-2x12	11-1	3-2x12
	9-9	4-2x12	11-0	4-2x12	12-0	4-2x12	11-11	4-2x12
36 ft.	5-1	3-2x8	5-9	3-2x8	6-3	3-2x8	6-9	3-2x8
	5-11	4-2x8	6-7	4-2x8	6-9	4-2x8	7-10	4-2x8
	6-6	3-2x10	7-4	3-2x10	8-1	3-2x10	8-8	3-2x10
	7-6	4-2x10	8-6	4-2x10	9-4	4-2x10	10-0	4-2x10
	7-11	3-2x12	8-11	3-2x12	9-9	3-2x12	10-7	3-2x12
	9-2	4-2x12	10-4	4-2x12	11-4	4-2x12	12-4	4-2x12

[1] This table provides maximum allowable spans in feet and inches for main beams or girders which are built-up from nominal 2-inch members.

[2] Fiber bending stress for various species and grades of wood is given in Appendix A21.

[3] The 2-inch members shall be laid on edge and fastened together with a double row of common nails not less than 3 1/2 inches in length. Nails shall be spaced not more than 18 inches apart in each row with the end nails placed 4 inches to 6 inches from the end of each piece.

[4] Where built-up wood beams are employed over a single span, the length of each individual piece used to fabricate the beam shall equal the length of the beam.

[5] Where built-up wood beams are continued over more than one span and where lengths of individual pieces are less than the total length of the complete beam, butt joints shall be located over supports or within 6 inches of the quarter points of the clear span. Where located near the quarter points, the joints in built-up beams shall be separated by at least one lamination and shall not exceed the beam width..

Steel Beams

Question: *Please explain the terminology for steel beams in Table 21.22-A1.*

Answer: *A-36 steel refers to the strength of the steel. It has an allowable tensile yield strength of 36,000 pounds per square inch.*

The designations W and M refer to the standard cross-sectional shapes of steel beams. The term I beam is no longer used, but does describe the general shape of these beams. The major differentiating characteristics of a beam are its top and bottom flanges which are horizontal and the vertical web which separates the flanges. The specific descriptions are:

"W" - The top and bottom flanges are parallel to each other. Previously called a wide flange beam in some cases.

"M" - Cannot be classified as a W or S shape. Sometimes referred to as a junior I beam previously.

It is always best to get the actual shape designation from the suppliers.
The two numbers after the shape designation (W, M) provide (1) the overall depth of the beam section and (2) the weight of the beam itself in pounds per lineal foot.

So a beam designated as a W 8 x 15 has a W shape with relatively wide flanges, a depth of 8 inches and weighs 15 pounds per lineal foot.

Question: *Table 21.22-A1 gives sizes for beams when conventional framing is used. Table 21.22-A2 gives sizes of wood beams when truss roofs are used. Are there any tables that can be used for steel girders and beams when using truss roofs?*

Answer: *The correct size of a steel beam can be obtained through use of the Steel Construction Manual published by the American Institute of Steel Construction, Inc. This is the same organization that publishes the standard as adopted in s. Comm 20.24(1). This manual contains tables covering different sizes and shapes of steel beams and specifies the maximum load the beam can carry for a certain span. Table A of the following commentary section (21.22(3)) can be used to determine the actual load on the beam. In order to determine the total load on the beam, the actual load on the beam in pounds per lineal inch as calculated by Table A must be multiplied by the number of inches between the supports. The table found in Chapter 2 of the Steel Construction Manual can then be used by selecting a beam and then comparing the actual load on the beam calculated with the maximum allowable load of the beam.*

Wood Girder and Beam Design

The beam design tables as given in the Uniform Dwelling Code may be used for the design or analysis of simple span timber beams and headers with uniformly distributed loads.

The structural analysis for simple beams and headers are based on the following formulas:

BENDING

$$M = \frac{w(l)^2}{8}, \quad S = \frac{M}{Fb}$$

HORIZONTAL SHEAR

$$Rv = \frac{w(l)}{2}, \quad Fv = \frac{3(Rv)}{2(b)(d)}$$

DEFLECTION $\quad \text{"Delta"} = \frac{5(w)\,(l)^4}{384\,(E)\,(I)}$ *(See Note D)*

w = uniform load per length in inches (See Note A)
l = length of beam between supporting members in inches
b = width of rectangular member (actual not nominal) in inches
d = depth of rectangular member (actual not nominal) in inches
S = section modulus of lumber (See Note B)
M = bending moment in inch-pounds
E = modulus of elasticity of lumber (See Note C) in psi
I = moment of inertia (See Note B) in (inches)^4
F = allowable unit stress for extreme fiber (See Note C) in psi
Fv = allowable unit horizontal shear (See Note C) in psi
Rv = vertical reaction in pounds
= deflection in inches

NOTE A - the uniform load per inch on a beam is calculated from the live loads (LL) and dead loads (DL) in pounds per square foot (s. Comm 21.02) and length in inches of supported joists (J). The formula is: $w = \frac{(DL + LL)\,(J)}{144}$

If more than one level is supported by beam or header, add the loads contributed by each ceiling, floor, and roof system supported to obtain the total uniform load per length on the beam. (See following diagram.)

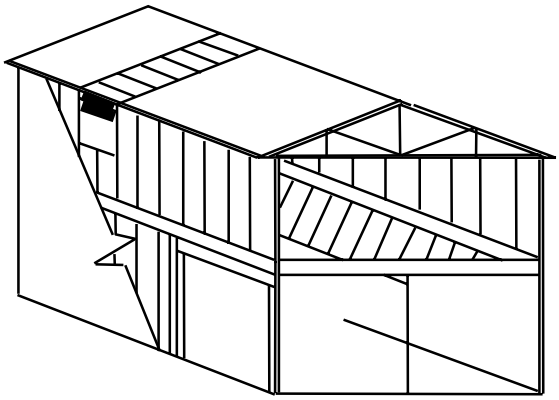
NOTE B - The National Design Specification for Wood Construction, Appendix M gives the value for (S) and (I) for structural lumber. If built up beams and headers are used, the (S) and (I) for each member can be added together if of the same depth for rectangular members:

$S = \frac{(b)(d)^2}{6}$ & $I = \frac{(b)(d)^3}{12}$

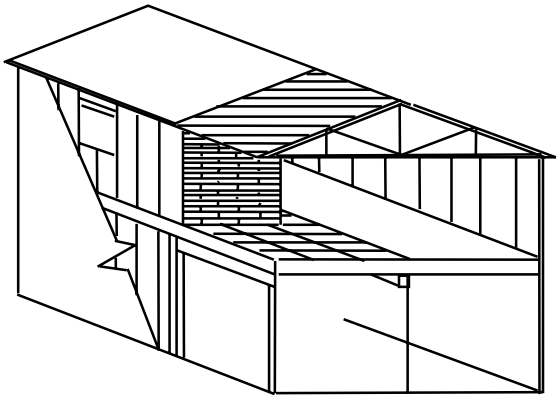
NOTE C - Fb, Fv and E for various wood species can be obtained from Table 4A in the Design Value for Wood Construction Supplement to the National Design Specification for Wood Construction. The values for Fb, Fv & E (allowable) for the wood species must exceed the calculated fb, fv & E values (actual).

NOTE D - Deflection "Delta" should be limited to $\frac{(l)}{240}$ to reduce plaster cracking, objectionable springiness, and stresses on mechanical systems.

Tributary Areas



Supported joist length equals ½ the sum of the joist plus ½ the required bearing area called for in the code or truss spans on both sides of beam or header



When the beam or header supports more than one structural system, the loads of each system are added.

The following two tables may be used to size beams or headers. Table A provides the actual loads per inch on the member for various loading situations.

TABLE A Designed to give load (w) on a beam or header for various roof, ceiling and floor systems in pounds per lineal inch. Includes dead and live loads. If multiple loads are supported by the beam or header, then add the loads together from the applicable columns.

Supported Member Length in Feet*	(w)** Roof Zone 1	(w)** Roof Zone 2	(w) Ceiling Truss No Storage	(w) Ceiling Joist No Storage	(w) Ceiling Joist With Storage	(w) Floor: Per System
4	15	13	3	7	10	17
5	19	15	4	9	13	21
6	22	18	5	10	15	25
7	26	21	6	12	18	30
8	31	25	7	14	21	35
9	34	27	8	16	24	39
10	38	30	9	18	26	43
11	41	34	10	19	29	47
12	44	37	11	21	31	51
13	49	40	12	23	33	56
14	53	42	13	24	37	60
15	56	45	14	26	39	64
16	60	48	15	28	42	69
17	64	51	16	29	44	73
18	66	53	17	31	46	76

**See previous page for diagrams. Note that you may need to use different lines of this table for a beam or header that supports multiple systems of different supported member length.*

***When there is a roof overhang, its length must be added to the supported member length.*

ACTUAL LOAD ON BEAM OR HEADER = ROOF (w) + CEILING (w) + FLOOR (w)

(4) BEARING AND END CONFIGURATION. (a) Sawn lumber. 1. 'Joists.' Wood joists made of sawn lumber shall meet the following bearing requirements:

a. Wood joists supported on wood or metal shall have a bearing surface of at least 1 1/2 inches measured from the end of the joist.

b. Wood joists supported on masonry or concrete shall have a bearing surface of at least 3 inches measured from the end of the joist.

c. The tail end of a floor joist may not extend past the edge of a beam by more than the depth of the floor joist.

d. Wood floor joists with ends that intersect over a beam shall have the ends overlap at least 3 inches and be securely fastened together with at least two 12d common nails or the ends shall be butt-jointed or face-jointed and fastened with ties, straps, plates or solid blocking.

2. 'Beams and girders.' Beams and girders made of sawn lumber shall have a bearing surface on their supports of at least 3 linear inches parallel to the beam or girder and be at least as wide as the beam or girder.

(b) Engineered wood products. Bearing surface for engineered wood products shall be in accordance with the manufacturer's instructions provided those instructions were developed through structural analysis or product testing and are applicable to the configuration.

Floor Joist Tails

Question: *Why can't the tail ends of joists overlap by more than the depth of the floor joist?*

Answer: *The reason for the requirement is to prevent potential subfloor uplift from the tail end reaction to the deflection of the joist span. This could be more of a problem at the center beam of a house in which the clear span roof trusses are used and there is no bearing wall resting on the floor joist tail ends.*

Question: *Can wood shims be used under a steel beam or under a steel column for minor dimensional adjustments? What about pressure treated lumber?*

Answer: *Maybe, but not likely, since the shim material used would need a compressive strength equal to or greater than the loads imposed by the typically highly loaded steel members . If structural calculations are lacking on this point, then steel shims would be required.*

(5) NOTCHING AND BORING. Notching and boring of beams or girders is prohibited unless determined through structural analysis.

(a) Notching of floor joists. 1. Notches located in the top or bottom of floor joists shall not have a depth exceeding 1/6 the depth of the joist, shall not have a length exceeding 1/3 the joist depth nor be located in the middle 1/3 of the span of the joist.

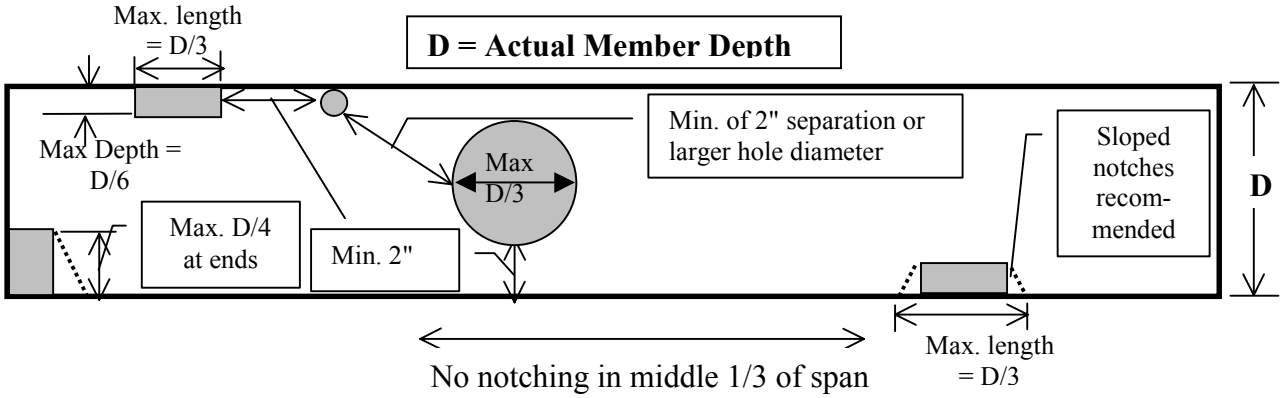
2. Where floor joists are notched on the ends, the notch shall not exceed 1/4 the depth of the joist. Notches over supports may extend the full bearing width of the support.

(b) Boring of floor joists. 1. 'General.' A hole may not be bored in a floor joist within 2 inches of a notch or another hole. In no case shall the distance between adjacent holes be less than the diameter of the larger hole.

2. 'Holes near the edge.' Holes bored in the top or bottom 2 inches of a joist shall follow the limitations for notching under par. (a).

3. 'Other holes.' Holes bored in floor joists that are not within 2 inches of the top or bottom of the joist shall have their diameter limited to 1/3 the depth of the joist.

Holes & Notches in Sawn Joists and Rafters (D = Actual Member Depth)			
Member Size	Maximum Hole Diameter or Notch Length = D/3	Maximum Edge-Hole Diameter or Notch Depth (except at ends) = D/6	Maximum End Notch = D/4
2x6	1-3/4"	7/8"	1-3/8"
2x8	2-3/8"	1-1/4"	1-7/8"
2x10	3"	1-1/2"	2-3/8"
2x12	3-3/4"	1-7/8"	2-7/8'



(c) Engineered wood products. Notching or boring of engineered wood products shall be done in accordance with the manufacturer's instructions provided those instructions were developed through structural analysis or product testing.

(6) OVERHANG OF FLOORS. (a) *General*. Except as provided in pars. (b) and (c), a floor joist overhang shall be cantilevered beyond the outer edge of the supporting wall below it by no more than the actual depth of the joist or shall be designed through structural analysis in accordance with s. Comm 21.02 (3).

(b) *Joist overhangs parallel to the main floor framing system*. Joist overhangs that are extensions of, and parallel to, the main floor framing system may extend beyond the depth of the joist without structural analysis provided they meet all of the following conditions:

1. The overhang is cantilevered no more than 2 feet beyond the outer edge of the supporting wall below it.

2. a. The overhang supports a uniform load limited to the weight of the bearing wall and the tributary roof area above it.

b. The tributary length of the roof area, excluding the eave overhang, is no more than 2 feet greater than the actual length of the joist directly below.

c. The eave overhang is no more than 2 feet.

Note: The tributary length is usually half the span of the joist or rafter

3. The joist overhang does not support any concentrated loads. For the purposes of this subsection, a framed opening in the wall with a rough opening of 4 feet or less shall be considered uniform loading.

4. a. The cantilevered joist is doubled at the supporting wall.

b. The doubled joist length extends inward beyond the inner edge of the supporting wall by the same distance as the cantilever.

c. The added joist member is secured to the main joist as stated in the nailing schedule in the appendix, under the heading for "floor framing, built-up girder and beams, top loaded".

(c) *Joist overhangs perpendicular to the main floor framing system.* Joist overhangs that are perpendicular to the main floor framing system, or lookout joists, may extend beyond the depth of the joist without structural analysis provided they meet all of the following conditions:

1. The joist overhang is cantilevered no more than 2 feet beyond the outer edge of the supporting wall below it.

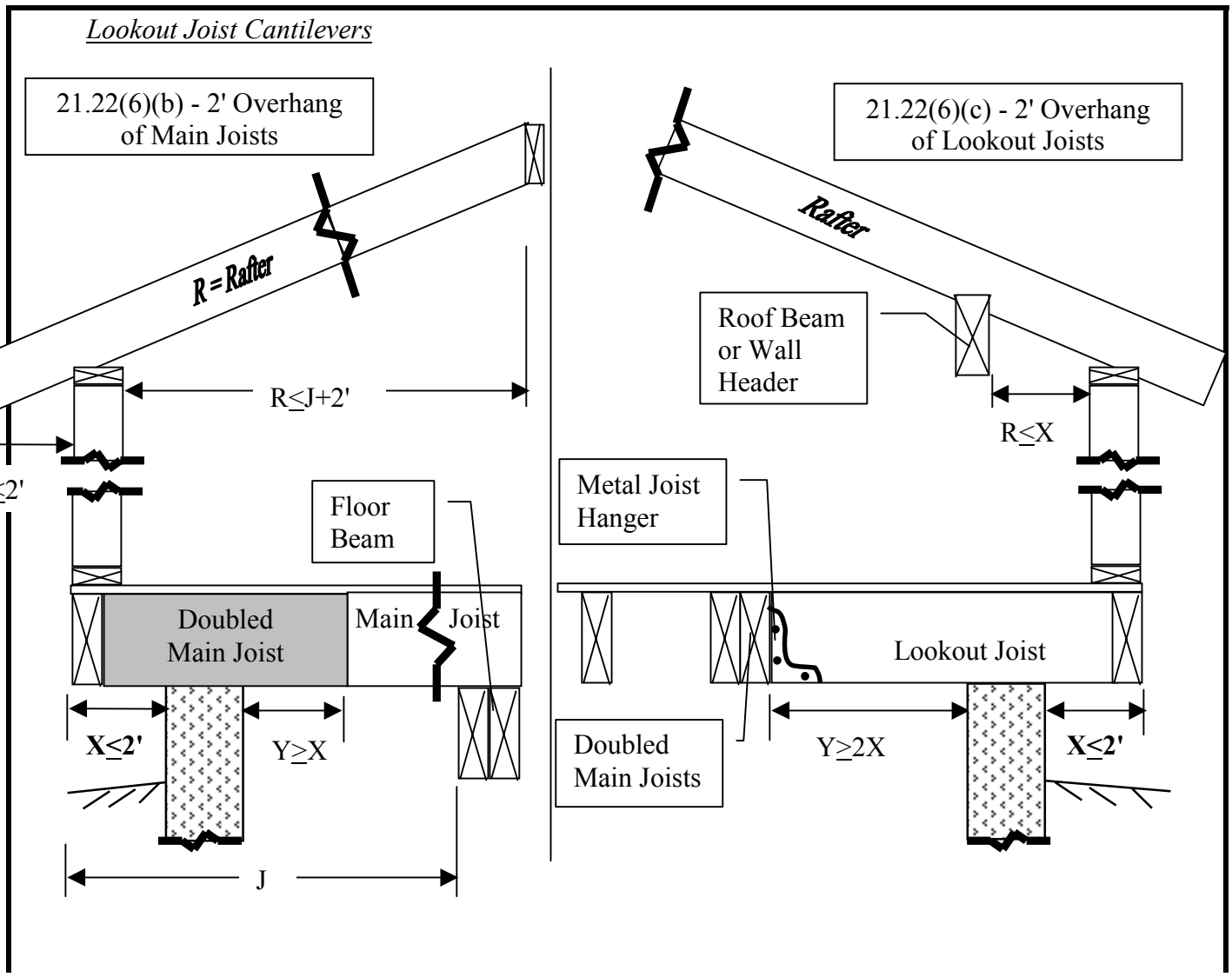
2. a. A double floor joist is used to support the lookout joist.

b. The double floor joist is located a distance of at least 2 times the cantilever length inward from the outer edge of the supporting wall below.

c. The lookout joists are fastened to the double joist with metal hangers.

3. The joist overhang supports no more than either a non-bearing wall or a wall that supports only a roof which spans no more than the floor overhang cantilever length plus the eave overhang**.**

(d) All overhangs longer than the depth of the supporting joist that do not meet all of the conditions under pars. (b) or (c) shall be designed through structural analysis.



Deck Cantilevers

Question: *This section allows a 2-foot cantilever that supports the wall and roof above without the need for calculations. Again, without project specific calculations being required, how far may a deck be cantilevered when it only supports its own floor load?*

Answer: *In the case of the code allowed 2-foot cantilever, the floor assembly is supporting its own known uniform floor load and a point load from the roof system of an unknown span. Therefore it is very conservative. In the proposed case of a cantilevered deck supporting only its own floor load, the loads are all known, therefore a more liberal treatment is possible. So theoretically, the cantilever could be one-half of the simple beam span. This would also parallel the requirement of s. Comm 21.22(6)(b) that the cantilever be anchored back two times the overhang. However, the owner may be unhappy with the deflection at the end of the deck, since for a given span, the deflection for a cantilever is about ten times that of a simple span.*

Besides the above analysis, the designer should evaluate the need for any uplift restraint on the backspan at the most critical loading where the cantilever has full live plus dead loads, while the backspan is under dead load only.

The deflection, non-uniform loading and uplift concerns, should be addressed by the designer. Also, the designer must confirm the assumption that the backspan joist is adequate for the simple span loading case before using the above formula to determine the cantilever length.

(7) FLOOR OPENINGS. Trimmers and headers shall be doubled when the span of the header exceeds 4 feet. Headers which span more than 6 feet shall have the ends supported by joist hangers or framing anchors, unless the ends are supported on a partition or beam. Tail joists (joists which frame into headers) more than 8 feet long shall be supported on metal framing anchors or on ledger strips of at least 2 inches by 2 inches nominal.

Joists Bearing Over Window Openings

In the absence of a wall header, the requirements of this section apply to floor joists that end above a window or other wall opening. This is typically the case for basement windows. Therefore, either framing anchors or a ledge strip, including a sill plate, is required for proper bearing for any joists over 8 feet long.

(8) FLOOR SHEATHING, BOARDS AND PLANKS. (a) Plywood sheathing. Plywood sheathing used for floors shall be limited to the allowable loads and spans shown in Table 21.22-B.

(b) Plywood underlayment. Plywood underlayment shall be installed in accordance with Table 21.22-C.

(c) Combination subfloor - underlayment. Combination subfloor - underlayment shall be installed in accordance with Table 21.22-D.

(d) Floor boards. Where wood boards are used for floor sheathing, the boards shall comply with the minimum thicknesses shown in Table 21.22-E.

(e) Planks. Planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed to each beam.

(9) BRIDGING. (a) Sawn lumber. Bridging shall be provided for sawn lumber framing at intervals not exceeding 8 feet where the nominal depth to thickness ratio is greater than 4 to 1.

(b) Engineered products. Bridging shall be provided for engineered framing products in accordance with the manufacturer's recommendations.

TABLE 21.22-B

ALLOWABLE SPANS FOR PLYWOOD FLOOR SHEATHING
CONTINUOUS OVER TWO OR MORE SPANS AND
FACE GRAIN PERPENDICULAR TO SUPPORTS[1]

Span Rating[2]	Plywood Thickness (in inches)	Maximum Span[3] (in inches)
32/16	15/32, 1/2, 5/8	16[5]
40/20	19/32, 5/8, 3/4, 7/8	20[4,5]
48/24	23/32, 3/4, 7/8	24

1 These values apply to C-D, C-C, and Structural I and II grades only. Spans shall be limited to values shown because of possible effect of concentrated loads.

2 Span Rating appears on all panels in the construction grades listed in footnote 1.

3 Plywood edges shall have approved tongue and groove joints or shall be supported with blocking, unless 1/4-inch minimum thickness underlayment or 1-1/2 inches of approved cellular or lightweight concrete is installed or finished floor is 25/32-inch wood strip. Allowable uniform load based on deflection of 1/360 of span is 165 pounds per square foot.

4 For joists spaced 24 inches on center, plywood sheathing with Span Rating 40/20 or greater can be used for subfloors when supporting 1-1/2 inches lightweight concrete.

5 May be 24 inches if 25/32-inch wood strip flooring is installed at right angles to joists.

TABLE 21.22-C

MINIMUM THICKNESS FOR PLYWOOD UNDERLAYMENT

Plywood Grades and Species Group	Application[1]	Minimum Plywood Thickness (inches)
Groups 1, 2, 3, 4, 5 APA UNDERLAYMENT INT (with interior or exterior glue) APA UNDERLAYMENT EXT APA C-C Plugged EXT	Over smooth subfloor	1/4
	Over lumber subfloor or other uneven surfaces	11/32
Same grades as above but Group 1 only	Over lumber floor up to 4" wide. Face grain must be perpendicular to boards	1/4
APA UNDERLAYMENT Sanded Exterior Grade	Over 16" joist spacing 19/32 subfloor, under tile with organic adhesive	11/32
	Over 16" joist spacing 19/32 subfloor, under tile with epoxy mortar	15/32[2]

1 Place face grain across supports and end joints over framing.

2 Leave 1/4" space at panel ends and edges, trim panels as necessary to maintain end spacing and panel support on framing. Fill joints with epoxy mortar. With single layer floors, use solid lumber backing or framing under all panel and edge joints, including T & G joints.

TABLE 21.22-D

MINIMUM THICKNESS FOR PLYWOOD COMBINATION SUBFLOOR-UNDERLAYMENT.
PLYWOOD CONTINUOUS OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR TO SUPPORTS[1,2]

		Maximum Support Spacing[3]		
		16" o.c.	20" o.c.	24" o.c.
Plywood Grade	Plywood Species Group	Panel Thickness (inches)	Panel Thickness (inches)	Panel Thickness (inches)
Sanded exterior type	1	1/2	5/8	3/4
	2 and 3	5/8	3/4	7/8
	4	3/4	7/8	1
Underlayment C-C Plugged Sturd-I-Floor[4]	All Groups	APA Rated Sheathing and APA Rated Sturd-I-Floor shall be installed consistent with their rating.		

[1] Spans shall be limited to values shown, based on possible effect of concentrated loads.

[2] Unsupported edges shall be tongue and groove or blocked except where 1/4-inch underlayment or 25/32-inch finish floor is used.

[3] Underlayment, C-C Plugged, sanded exterior type: allowable uniform load based on deflection of L/360 span for spans 24 inches or less is 125 psf; and for spans 48 inches, 65 psf.

[4] The department will accept subfloor underlayment panels such as Sturd-I-Floor which meet the requirements of APA manufacturing specifications for Sturd-I-Floor panels.

TABLE 21.22-E

MINIMUM THICKNESS OF FLOOR BOARDS

	Minimum Net Thickness (inches)	
Joint Spacing (inches)	Perpendicular to Joist	Diagonal to Joist
24	11/16	3/4
16	5/8	5/8

Comm 21.225 Decks.

Decks attached to dwellings and detached decks which serve an exit shall comply with the applicable provisions of this chapter, including but not limited to:

(1) Excavation requirements of s. Comm 21.14;

(2) Footing requirements of s. Comm 21.15 (1) (f);

(3) Frost penetration requirements of s. Comm 21.16;

(4) Load requirements of s. Comm 21.02;

(5) Stair, handrail and guardrail requirements of s. Comm 21.04; and

(6) Decay protection requirements of s. Comm 21.10.

Subchapter VII — Walls

Comm 21.23 Wall design.

(1) LIVE AND DEAD LOADS. All walls shall support all superimposed vertical dead loads and live loads from floors and roofs.

(2) HORIZONTAL WIND LOAD. Walls shall be designed to withstand a horizontal wind pressure of at least 20 pounds per square foot applied to the vertical projection of that portion of the dwelling above grade. No wind load reduction shall be permitted for the shielding effect of other buildings.

Comm 21.24 Exterior covering.

(1) GENERAL. The exterior walls shall be covered with a permanent weather resistant finish.

(2) DURING CONSTRUCTION. During construction, wall cavity insulation may not be installed until a water-resistant exterior covering is in place over the wall cavity.

Note: An example of acceptable water-resistant covering is foam sheathing with taped joints and the permanent doors and windows installed.

(3) FLASHING. (a) Corrosion-resistant flashing shall be installed in the exterior wall to prevent water from entering the wall cavity or coming in contact with the structural framing components.

(b) The flashing shall extend to the surface of the exterior wall finish and prevent water from reentering the exterior wall.

(c) Flashing shall be provided at all of the following locations:

1. At the top of all exterior door and window openings, unless using self-flashing windows that provide at least one inch of flashing around the opening, including the corners.

2. At the intersection of chimneys or other masonry construction with frame walls.

3. Under and at the ends of masonry, wood or metal copings and sills.

4. Continuously above all projecting wood trim.

5. Where porches, decks or stairs attach to a wall or floor assembly of wood frame construction.

6. At wall and roof intersections.

7. At built-in gutters.

Exterior Covering

Question: *When is it necessary to have building paper or some other moisture resistant membrane under the exterior siding or other covering?*

Answer: *Building paper or a similar product is required if the exterior finish material or the underlying material does not provide the required continuous moisture-*

resistant covering. The department accepts the following as meeting this requirement:

- *Exterior-rated panelized siding with joints caulked, lapped, flashed or battened.*

- *Any moisture-resistant covering applied over building sheathing panels such as plywood, foamboard or fiberboard.*

The department does not accept the following exterior covering unless applied over building paper or the equivalent:

- *Lap siding applied directly to studs (no sheathing).*
- *Wood shakes or shingles.*

However, if the manufacturer's/supplier's installation requirements for the chosen finish material direct the use of building paper, then that would be the controlling requirement.

***Question**: Must the siding or finished surface material be in place before insulation can be installed?*

***Answer**: No, so long as it is "protected" from the elements which could cause excessive moisture in the finished walls. This "protection" could be any of the materials above.*

Comm 21.25 Wood frame walls.

Unless designed through structural analysis, wood frame walls shall comply with the following requirements.

(1) STUD CONFIGURATION AND BRACING. (a) Studs. Wood studs shall comply with the size and spacing requirements indicated in Table 21.25-A. Studs in the exterior walls shall be placed with the wide faces perpendicular to the plane of the wall.

TABLE 21.25-A

MAXIMUM UNBRACED STUD LENGTH WITH SPACING AND LOADING

			Spacing (inches)			
Size	Grade	Maximum height (feet)	Supporting roof and ceiling only	Supporting one floor, roof and ceiling	Supporting two floors, roof and ceiling	Interior and nonload-bearing
2x3	Standard & better	8	16	N/P	N/P	24
2x4 or larger	Utility	8	24	16	12	24

2x4	Standard or better	10	24	24	12	24
2x6 or larger	No. 3 & better	10	24	24	16	24

N/P = Not permitted.

Note: A 3-story frame house with walls constructed of 2 x 4 standard grade studs would require a 12-inch stud spacing on the lowest level, a 24-inch stud spacing on the intermediate level, and a 24-inch stud spacing on the upper level.

Question: *Based on Table 21.25-A, if I have an exterior gable end-wall with a cathedral ceiling that is greater than the stud height allowed, do I have any options other than cutting the studs and installing double top plates?*

Answer: *Yes, if the allowable height is exceeded, there are two ways of handling this condition:*

1. *If the maximum allowed stud length is 10 feet,* ***continuous 2" full-depth solid wood blocking*** *could be installed throughout the wall between all studs at the mid-point of the wall height (but in no case exceeding the 10' limitation).*

2. *The second option would be to install solid wood sheathing material on both the exterior and the interior of this stud wall, covering the entire wall area (under the interior wall finish).*

(b) Bracing. Exterior walls shall be braced at the corners.

1. Nominal 1-inch by 4-inch continuous diagonal members set into the face of the studs at an angle between 45° and 60°; or

2. Four feet by 8 feet plywood sheathing panels not less than 5/16 inch thick for 16-inch stud spacing and not less than 3/8 inch thick for 24-inch stud spacing; or

3. Preformed metal T-bracing not less than 22 gage (.0296 inches) thick and 1 3/4 inches wide; or

4. Other approved wind bracing materials.

Note: See Appendix for acceptable nailing schedule.

Corner Bracing

Question: *Is the required wind bracing allowed to be installed at other locations than the corners?*

Answer: *Yes, if the design of the dwelling prevents wind bracing at a corner due to windows or other features, then it may be located at the next available wall space. The purpose of the bracing, to reduce racking or the movement of the top of the house relative to the bottom, would still be served.*

(2) TOP PLATES. (a) General. Except as allowed under subd. 3., top plates shall be provided and configured as follows:

1. Studs at bearing wall shall be capped with double top plates.

2. End joints in double top plates shall be offset at least 2 stud spaces.

3. Double top plates shall be overlapped at the corners and at intersections of partitions.

4. The plate immediately above a stud may have a joint only when directly over the stud.

(b) Notching and boring. 1. When piping or ductwork is placed in an exterior wall or an interior load-bearing wall, such that at least half of the width of the top plate is removed, the plate shall be reinforced with a steel angle at least 2 inches by 2 inches by 20 gauge thick.

Note: 20 gauge is approximately 0.036 inch.

2. The steel angle shall span the gap and extend at least to the midpoint of the adjacent stud spaces.

3. Other equivalent materials may be used in accordance with s. Comm 21.02.

(c) Exceptions. 1. A single top plate may be used in place of a double top plate provided a rafter is located directly over the studs and the plate is securely tied at the end joints, corners and intersecting walls. Joints may occur in single top plates only when directly over a stud.

2. A continuous header, consisting of two 2-inch members set on edge, may be used in place of a double top plate provided the header is securely tied to the adjacent wall.

(3) WALL OPENINGS. Where doors or windows occur, headers shall be used to carry the load across the opening.

(a) Header size. The size of headers shall be determined in accordance with the spans and loading conditions listed in Tables 21.25-B, 21.25-C and 21.25-D. Headers for longer spans shall be designed by an engineering method under s. Comm 21.02.

TABLE 21.25-B

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING
ROOF/CEILING ASSEMBLIES*

House Width (feet)	Header Members									
	Two 2 x 4s		Two 2 x 6s		Two 2 x 8s		Two 2 x 10s		Two 2 x 12s	
	Zone 2/Zone 1		Zone 2/Zone1		Zone 2/Zone 1		Zone 2/Zone 1		Zone 2/Zone 1	
24	2.5	2.5	4	4	5	5	7	6	9	8
26	2.5	2	4	3	5	5	7	6	8	7
28	2.5	2	4	3	5	4	6	6	8	7
30	2.5	2	4	3	5	4	6	6	8	7
32	2	2	3	3	5	4	6	5	7	7

TABLE 21.25-C

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR*

House Width (feet)	Header Members				
	Two 2 x 4s	Two 2 x 6s	Two 2 x 8s	Two 2 x 10s	Two 2 x 12s
24	2.5	4	5	6	8
26	2.5	3	5	6	8
28	2	3	5	6	7
30	2	3	4	6	7
32	2	3	4	5	7

TABLE 21.25-D

ALLOWABLE SPANS (FEET) FOR HEADERS SUPPORTING ONE FLOOR
AND ROOF/CEILING ASSEMBLY*

House Width (feet)	Header Members									
	Two 2 x 4s		Two 2 x 6s		Two 2 x 8s		Two 2 x 10s		Two 2 x 12s	
	Zone 2/Zone 1		Zone 2/Zone1		Zone 2/Zone 1		Zone 2/Zone 1		Zone 2/Zone 1	
24	1.5	1.5	3	2.5	4	3	5	4	6	5
26	1.5	1.5	2.5	2.5	3	3	4	4	5	5
28	1.5	1.5	2.5	2.5	3	3	4	4	5	5
30	1.5	1.5	2.5	2.5	3	3	4	4	5	5
32	1.5	1.5	2.5	2	3	3	4	4	5	5

* These tables are based on wood with a fiber bending stress of 1,000 psi. For other species with different fiber bending stresses, multiply the span by the square root of the ratio of the actual bending stress to 1,000 psi. Example: From ~~Table 21.25-~~B, the allowable roof/ceiling span for a 28-foot wide house in zone 2, using two 2 x 8 header members with a 1400 psi bending stress, is 5 feet x $\sqrt{1400/1000}$ = 5.9 feet.

(b) Header support. Headers in bearing walls shall be supported in accordance with subd. 1. or 2. or 3.

1. Headers 3 feet or less in length shall be directly supported on each end by either:

a. The single common stud and a shoulder stud; or

b. The single common stud with a framing anchor attached.

2. Headers greater than 3 feet but less than or equal to 6 feet in length shall be directly supported on each end by the single common stud and a shoulder stud.

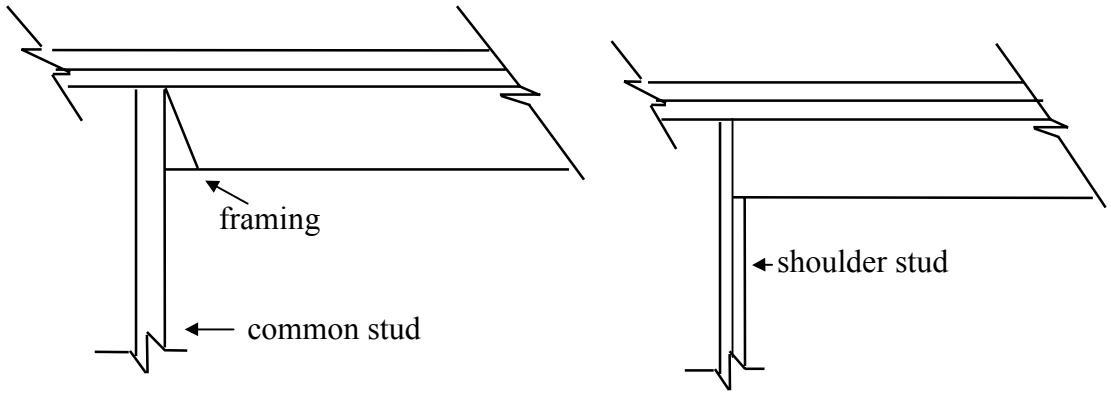
3. Headers greater than 6 feet in length shall be directly supported on each end by the single common stud and 2 shoulder studs.

Header Sizing

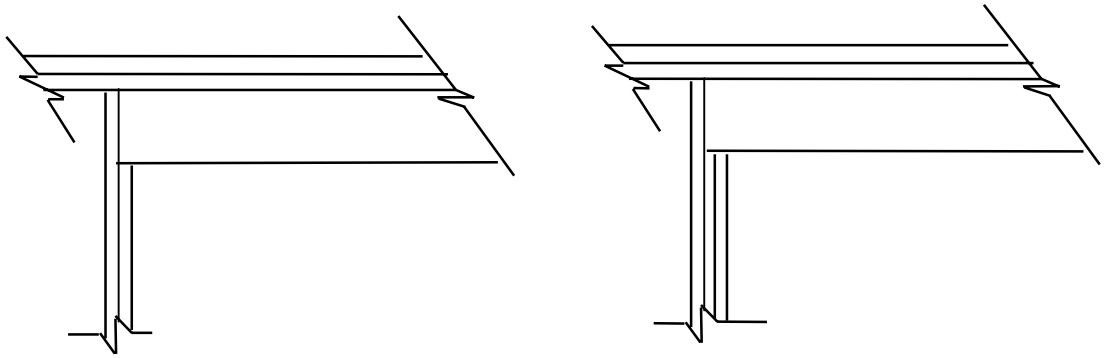
For headers exceeding the spans given in Tables 21.25-A, C, and D, see s. 21.22(3) of this commentary for design information.

Header Support

This section prescribes header support standards. The following diagrams are intended to clarify the text.. Remember that the "span" is the clear span plus ½ the required bearing area of the header at each end.



Either option for up to a 3-foot span.



From 3- to 6-foot span

Greater than 6-foot span

(4) NOTCHING. Notching and boring of columns or posts is prohibited unless designed through structural analysis. Studs shall not be cut or bored more than 1/3 the depth of the stud, unless the stud is reinforced.

(5) PARTITIONS. Load-bearing partitions shall be placed over beams, girders, or other load-bearing partitions. Load-bearing partitions running at right angles to the joists shall not be offset from the main girder or walls more than the depth of the joist unless the joists are designed to carry the load.

(6) POSTS AND COLUMNS. (a) General. 1. Posts and columns shall be installed to resist imposed loads.

2. Posts and columns shall bear directly over the middle 1/3 of a footing.

3. Posts and columns shall be restrained at the top and bottom to resist displacement.

4. Posts and columns that use a height adjustment mechanism shall have the mechanism imbedded in concrete or permanently disabled after installation.

(b) Bearing surface. Posts and columns shall have a steel bearing plate affixed to one or both ends to distribute any applied loads and to prevent fiber crushing of any structural member being supported.

(c) Steel posts or columns. Steel posts or columns shall be sized according to one of the following methods:

1. Manufactured columns shall follow the manufacturer's testing and listing.

2. Columns made solely of steel pipe stock shall follow Table 21.25-E.

3. Columns made of steel stock, not meeting the requirements of subd. 3. a. or b., shall follow a nationally accepted design specification or the size shall be determined through structural analysis or load testing.

(d) Wood posts or columns. Wood posts or columns shall be sized according to Table 21.25-F or the size shall be determined through structural analysis or load testing.

Table 21.25-E

COLUMNS MADE OF STEEL PIPE STOCK [1,2]

Column Diameter (inches)	Wall Thickness (inches)	Weight/ft (pounds)	Height (feet)	Allowable Load (pounds)
3	0.216	7.58	8	34,000
			10	28,000
			12	22,000
3.5	0.226	9.11	8	44,000
			10	38,000
			12	32,000
4	0.237	10.79	8	54,000
			10	49,000
			12	43,000
5	0.258	14.62	8	78,000
			10	73,000
			12	68,000
6	0.280	18.97	8	106,000
			10	101,000
			12	95,000

Note 1: This Table is based on a yield strength or Fy of 36,000 psi.

Note 2: This table is for columns made solely of steel pipe stock. The addition of any adjustment mechanism or other feature will alter the load-carrying capacity of the column.

Table 21.25-F

WOOD COLUMNS

Wood Nominal Size (inches)	Cross Section Area (inches)	Height (feet)	Allowable Load (pounds)
4 x 4	12.25	8	4,900
		10	3,100
		12	2,150
4 x 6	19.25	8	7,700
		10	4,900
		12	3,400
6 x 6	30.25	8	30,000
		10	18,900
		12	13,300

Note: This Table is based on a modulus of elasticity or E of 1,000,000 psi and a fiber bending strength or Fb of 1,000 psi.

Telescoping Columns

Question: *Are telescoping/expandable jacks or columns allowed in the construction of one- and two-family dwellings?*

Answer: *The use of the telescoping jack post (adjustable height columns) to support beams is not prohibited by the UDC provided they are capable of supporting the imposed loading. The installation shall comply with the manufacturer's installation instructions for spacing, load capacity, maximum height adjustment, beam or footing anchorage and proper method to secure the adjustment device while in service. The adjustable jack should be stamped or bear a sticker which indicates its allowable load. They must be secured at both the top and bottom of the column the same as any other column.*

Comm 21.26 Masonry walls.

Masonry walls shall be constructed in accordance with the requirements of this section.

(1) COLD WEATHER WORK. In cold weather, provisions shall be taken to prevent masonry from being damaged by freezing.

Note: It will be the practice of the department to accept performance with "Recommended Practices for Cold Weather Masonry Construction," available from International Masonry Institute, 823 15th Street NW, Washington, D.C. 20005.

(2) MASONRY UNITS. (a) Unused concrete units. Previously unused concrete masonry units shall conform to the ASTM C 90 standard.

(b) Unused clay or shale units. Previously unused clay or shale masonry units shall conform to the appropriate ASTM standard: C 62; C216; or C 652. Units which will be exposed to weathering or frost action shall be Grade SW as specified in these standards.

(c) Used masonry units. All previously used masonry units shall be free from physical defects which interfere with the installation or impair the structural properties of the unit.

(3) TYPES OF MORTAR. The type of masonry mortar to be used for various kinds of masonry work shall be determined from Table 21.26-A. The mortar shall conform to the property requirements of Table 21.26-B1 and to the requirements of ASTM C-270 or shall be mixed in accordance with the proportions specified in Table 21.26-B.

(a) Surface bond mortars. Surface bond mortars for masonry walls shall be mixed in accordance with the proportions specified on the bag.

(4) MORTAR COMPONENTS. Mortar components shall comply with the following requirements:

(a) Water. Water shall be clean and free of deleterious amounts of acids, alkalies, or organic materials.

(b) Admixtures or mortar colors. Admixtures or mortar colors shall not be added to the mortar unless the resulting mortar conforms to the requirements of the mortar specifications. Only calcium chloride may be used as an accelerant and shall be limited to 2% by weight of the cement used. Calcium chloride may not be used for any other purpose. Only mineral oxide may be used as mortar color and shall not exceed 10% by weight of the cement used.

(c) Mixing. Mortar shall be mixed for at least 3 minutes after all ingredients have been added with the maximum amount of water to produce a workable consistency. Mortars that have stiffened due to water evaporation shall be retempered by adding water as frequently as needed to restore the required consistency. Mortars shall be used and placed in final position within 2 1/2 hours after mixing.

Note: To ensure proper mortar mixing, machine mixing is recommended.

TABLE 21.26-A

TYPES OF MORTAR FOR VARIOUS KINDS OF MASONRY

Kind of Masonry	Types of Mortar
Foundations:	
Footings	M, S
Walls of solid units	M, S, N
Walls of hollow units	M, S
Hollow walls	M, S
Masonry other than foundation masonry:	
Piers of solid masonry	M, S, N
Piers of hollow units	M, S
Walls of solid masonry	M, S, N, O
Walls of solid masonry not less than 12 in. thick or more than 35 ft. in height, supported laterally at intervals not exceeding 12 times the wall thickness	M, S, N, O
Walls of hollow units; load-bearing or exterior, and hollow walls 12 in. or more in thicknes	M, S, N
Hollow walls, less than 12 in. thic	M, S, N
Linings of existing masonry, either above or below grad	M, S
Masonry other than above	M, S, N

TABLE 21.26-B

MORTAR SPECIFICATIONS BY PROPORTION[1]

Mortar Type, ASTM C270	Parts by Volume			
	Portland Cement	Masonry Cement	Hydrated Lime	Sand, Damp Loose Volume
M	1	---	1/4	Not less than 2 1/2 and not more than 3 times the sum of the volumes of the cements and lime.
	1	1 (Type II)	---	
S	1	---	1/4 to 1/2	
	1/2	1 (Type II)	---	
N[2]	1	---	1/2 to 1 1/4	
	---	1 (Type II)	---	

1 All cements are one cubic foot per sack; lime equals 1 1/4 cubic foot per sack.

2 Limited to walls with a maximum depth of 5 feet below grade.

TABLE 21.26-B1

MORTAR PROPERTY REQUIREMENTS

Mortar Type	Compressive Strength Min. (psi)	Water Retention Min. (%)	Air Content Max. (%)
M	2,500	75	18
S	1,800	75	18
N	750	75	18

(d) Cementitious material. Cementitious material shall conform to the standards approved by the department.

Note: The department will accept cementitious material conforming to the following standards: ASTM C91, Masonry Cement; ASTM C150, Portland Cement; ASTM C595, Portland Blast-Furnace Slag Cement; ASTM C207, Hydrated Lime for Masonry Purposes; and ASTM C5, Quick Lime for Structural Purposes.

(e) Aggregates. Aggregates for use in masonry mortar shall consist of natural sand or manufactured sand and shall be graded.

Note: The department will accept aggregates in accordance with ASTM C144.

(5) CAVITY WALL. (a) Corbeling. Cavity wall construction may be supported on an 8-inch foundation wall provided the 8-inch wall is corbeled with solid masonry to the width of the cavity wall. Individual corbels shall not exceed 2 inches nor more than one-third the height of each corbeled unit.

(b) Projections. The projection of a wall beyond the edge of a supporting member other than masonry, such as a shelf angle or edge of a beam, shall not exceed 1 1/4 inches, unless at least 2/3 the mass of the wythe of masonry involved is located directly over the load-carrying member.

(c) Flashing. In exterior hollow walls exposed to the weather, flashing shall be installed at the bottom of the cavity formed by openings such as lintels over doors and windows and the backsides of chimneys so as to drain any water outward. Open vertical joints or weep holes of 3/8-inch minimum diameter shall be provided in the facing directly above the flashing at a horizontal spacing not exceeding 3 feet.

(6) OPENINGS AND LINTELS. (a) Openings. The masonry above openings shall be supported. The bearing length of structural elements which support the masonry above the opening shall be not less than 4 inches.

(b) Lintels. Unless designed through structural analysis, lintels shall be provided using either steel angles or reinforcing bars in accordance with Table 21.26-C.

TABLE 21.26-C

ALLOWABLE SPANS FOR LINTELS SUPPORTING MASONRY VENEER

Size of Steel Angle[1,3]	No Story Above	One Story Above	Two Stories Above	No. of 1/2" or Equivalent Reinforcing Bars[2]
L3 x 3 x 1/4	6'-0"	3'-6"	3'-0"	1
L4 x 3 x 1/4	8'-0"	5'-0"	3'-0"	1
L6 x 3 1/2 x 1/4	14'-0"	8'-0"	3'-6"	2
2 - L6 x 3 1/4 x 1/4	20'-0"	11'-0"	5'-0"	4

1 Long leg of the angle shall be placed in a vertical position.

2 Depth of reinforced lintels shall be not less than 8 inches and all cells of hollow masonry lintels shall be grouted solid. Reinforcing bars shall extend not less than 8 inches into the support.

3 Steel members indicated are adequate typical examples; other steel members meeting structural design requirements may be used.

(7) MASONRY VENEERS. (a) Veneer over frame construction. 1. Masonry veneers may be corbeled over the foundation wall, but the corbeling shall not exceed one inch.

2. An air space shall be provided between the veneer and the sheathing.

3. Where no brick ledge is formed in the foundation wall, corrosion resistant metal or other water resistant flashing shall extend over the top of the foundation wall from the

outside face of the wall and shall extend at least 6 inches up on the sheathing. The flashing shall be installed to drain any water outward.

4. Weep holes shall be provided at the bottom masonry course at maximum intervals of 2 feet.

(b) Veneer over masonry back-up. Corrosion-resistant metal or other water-resistant base flashing shall be provided at the bottom of the veneer and shall extend over the top of the foundation and up at least 6 inches and be embedded in the back-up course. The flashing shall be installed to drain any water outward. Weep holes shall be provided at maximum intervals of 3 feet.

(8) VENEER ANCHORAGE. All veneers, supports and attachments shall be mechanically or adhesively anchored.

(a) Mechanical anchorage. All anchors shall be corrosion-resistant.

1. Conventional size veneer (one square foot or less) shall be securely attached to its backing by anchors the equivalent of No. 22 U.S. gauge corrugated sheet steel 7/8 inch wide with at least one such tie located in every 2 square feet of wall. Ties shall be embedded 2 inches in a masonry joint and nailed to the framing with an 8d nail.

2. Large size veneer (greater than one square foot) shall be securely attached with anchors the equivalent of not less than 1/4-inch diameter bolts in accordance with either of the following:

a. Each unit individually anchored to the supporting framework with at least 3 anchors.

b. Individual units doweled to each other at all horizontal joints and anchored to the backing at all horizontal and vertical joints so that one anchor is provided for every 6 square feet of wall surface.

(b) Adhesive anchorage. Veneer may be cemented to a masonry or concrete wall or to exterior portland cement plaster in high rib galvanized metal lath with an adhesive, provided that the bond is sufficient to withstand a shearing stress of 50 psi after curing for 28 days.

(9) BEARING. (a) Concentrated loads. Beams, girders, trusses, joists and other members producing concentrated loads shall bear a minimum of 3 inches on one of the following:

1. Concrete beam. The equivalent of a nominally reinforced 2,500 psi concrete beam 8 inches in height.

2. Solid masonry. At least 8 inches in height of masonry composed of solid masonry units with all voids and joints completely filled with mortar.

3. Metal plate. A metal plate of sufficient thickness and size to distribute the load to masonry units. For piers and columns, the bearing plate shall not exceed 60% of the cross-sectional area of the pier or column and the resultant reaction of all vertical and horizontal loads shall fall within the middle third of the member.

4. Bond beam. The bond beam shall be the equivalent of not less than an 8-inch lintel (bond beam) block with 2 No. 4 bars embedded in high strength mortar fill or equivalent. The loads shall bear on the fill.

(b) Continuous loads. Joists, trusses and beams other than wood, spaced 4 feet or less on center and 40 feet or less in length, slabs or other members causing continuous loads shall be transmitted to masonry with a minimum bearing of 3 inches upon solid masonry at least 2 1/2 inches in height, or as indicated for concentrated loads.

(c) Stack bond walls. Concentrated loads shall be distributed into masonry laid in stack bond by a concrete beam or bond beam [as defined in (a)]. For masonry of solid units, 2 additional rows of a continuous tie assembly may be used instead of a concrete beam or bond beam.

(d) Support of wood floor members. Where a wood structural member is buried in masonry for support, it shall be firecut or a self-releasing device shall be used. Where the end of a wood structural member is built into an exterior wall, a 1/2-inch air space shall be provided at the sides, top and end of such member.

(10) BONDING. Unless designed through structural analysis, all masonry walls shall be bonded as follows:

(a) Single-wythe walls. Masonry units in single-wythe walls shall be lapped at least 2 inches or one-third the height of the masonry unit, whichever is greater, or through the use of continuous tie assemblies spaced at 16-inch vertical intervals.

(b) Multi-wythe walls. Adjacent wythes shall be bonded with continuous tie assemblies spaced at vertical intervals not exceeding 16 inches; or individual ties of at least 3/16-inch diameter for each 4 1/2 square feet of wall area, spaced at a maximum vertical distance of 18 inches and a maximum horizontal distance of 36 inches; or bonded with a full course of masonry headers every seventh course. The clear distance between bond courses shall not exceed 16 inches for solid masonry units and 24 inches for hollow masonry units. Hollow walls shall not be bonded with headers.

(11) BOLTS AND ANCHORS. The allowable shear on steel bolts and anchors shall not exceed the values given in Table 21.26.

TABLE 21.26

ALLOWABLE SHEAR ON BOLTS AND ANCHORS

Bolt or Anchor Diameter (inches)	Embedment1 (inches)	Allowable Shear (pounds)
1/4	4	270
3/8	4	410
1/2	4	550
5/8	4	750
3/4	5	1100
7/8	6	1500
1	7	1850
1 1/8	8	2250

1 Bolts and anchors shall be solidly embedded in mortar or grout.

(12) JOINTS. (a) The maximum thickness of a mortar joint shall be 1/2 inch.

(b) Except for head joints used for weepholes and ventilation, solid masonry units shall be laid to achieve full head and bed joints.

(c) Hollow masonry units shall be laid with full head joints and full bed joints under the full bearing areas of the face shells and under webs where the adjacent cells are to be filled with grout.

(13) CLEANING. Chemical cleaning agents shall be prevented from harming the metal reinforcement of structural components and shall not be of a strength which will adversely affect the mortar.

Subchapter VIII — Roof and Ceilings

Comm 21.27 Roof design.

(1) ROOF LOADS. (a) General. Roof and roof/ceiling assemblies shall support all dead loads plus the minimum live loads as set forth in par. (b) and s. Comm 21.02.

(b) Slope roof snow loads. Snow loads specified in s. Comm 21.02 (1) (b) 2. may be reduced for roof slopes greater than 30° by multiplying the snow load by Cs. The value of Cs shall be determined by the following: Cs = 1 - (a-30) where a is the slope of the roof expressed in degrees.

Roof Loads

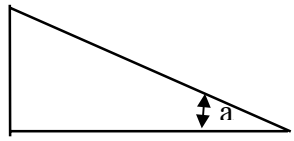
Question: *Can maximum spans of roof rafters be increased through the use of collar ties?*
Answer: *No, unless structural calculations are provided to document the acceptability of the design. Collar ties are already minimally required by s. Comm 21.28(2) to resist roof deflection and do not increase the allowable span of the rafters.*

Sloped Roof Snow Loads

This section allows reduction of snow loads on roofs sloped more than 30 degrees. This means a reduction may be taken on roofs with greater than a 7:12 slope. This reduced design snow load may be transmitted down through the structure including any headers or beams. (See Examples.)

However, it must be remembered that s. Comm 20.02 also requires a 20 PSF wind load acting on the vertical roof projection.

Reduced Snow Load for High Slope Roofs = Cs X Design Snow Load
Cs = [1 - (a - 30)]/40
a = angle in degrees



Rise/Run = Slope = tan a
Arctan(slope) = a

Slope	a	Zone 1 PSF	Zone 2 PSF
7/12	30	40	30
10/12	40	30	22.5
12/12	45	25	18.8
14/12	50	20	15

(2) UPLIFT AND SUCTION FORCES. Roofs shall withstand a pressure of at least 20 pounds per square foot acting upward normal to the roof surface. Roof overhangs, eaves, canopies and cornices shall withstand an upward wind pressure of at least 20 pounds per square foot applied to the entire exposed area.

(a) Anchorage. Roofs shall be anchored to walls and columns to resist uplift.

(b) Stress increase. All stresses may be increased by a maximum of one-third for wind forces.

(3) WATER. All roofs shall be designed and constructed to assure drainage of water.

(a) Roofing. 1. General. a. Underlayment consisting of number 15 asphalt-impregnated felt paper or equivalent or other type I material that shows no water transmission when tested in accordance with ASTM D 226 or ASTM D 4869 shall be provided under shingles.

Note: Underlayment materials meeting the requirements of ASTM D 1970 meet the performance requirements of this section.

b. Fasteners shall be corrosion resistant.

Note 1: See Comm 20.07 (62) for definitions of shingle terms.

Note 2: The Residential Asphalt Roofing Manual can be purchased from the Asphalt Roofing Manufacturers Association at 6000 Executive Boulevard, Suite 201, Rockville, Maryland 20852-3803. This manual contains extensive information on shingles from manufacture through installation, inspection and maintenance. It includes a recommendation that properly driven and applied nails are the preferred fastening system for asphalt shingles.

Note 3. Section Comm 20.04 (2) requires compliance with all parts of this code, including these roofing provisions, for an alteration to any dwelling that is regulated under this code.

2. Asphalt shingles. a. Organic asphalt shingles shall conform to ASTM D 225 and the Class C requirements of ASTM E 108, and shall pass the wind resistance test of ASTM D 3161.

b. Fiberglass asphalt shingles shall conform to ASTM D 3462 except that laminated shingles shall have a tear strength of at least 1450 grams in each ply.

c. Shingles that have a self-sealing adhesive strip shall include a sealant which has an average bond strength of at least 1.5 pounds per 3.75 inches of shingle width, at 32°F.

Note: The department will accept the results of testing conducted in accordance with an approved test method for verifying compliance with the sealant uplift resistance required in this subparagraph. Information on the applicable test method may be obtained from the department.

d. Each shingle package shall be labeled by the manufacturer to indicate conformance to the applicable ASTM standard for each type of shingle or the exception in subpar. b.

e. Shingles shall be installed in accordance with the manufacturer's recommendations. Shingles shall have at least 4 fasteners per strip shingle or 2 fasteners per interlocking shingle. Shingle head lap shall be at least 2 inches.

Roofing

Question: *Can metal roofing be used?*
Answer: *The requirements under s. Comm 21.27 for roof design makes no reference to the specific type of material that can or cannot be used as a roof covering. Therefore, metal roofing material is acceptable if installed consistent with the manufacturer's instructions.*

Question: *Can re-roofing be done without removing the existing layers of roofing?*
Answer: *The subject of the number of layers of roofing materials that can be placed on a roof system is not addressed in the dwelling code specifically. However, the design loads of the roof rafter or trusses should not be exceeded. The span tables in the UDC assume dead loads that will typically allow a total of two lightweight roof layers. Additionally, the installation of the roof covering materials would have to be in accordance with the manufacturer's recommendations, installation instructions, and warranty provisions.*

(b) *Ice dam protection*. 1. Shingled or shake roofs that extend over a heated area of a dwelling or attached garage and that have a slope of 4:12 or less shall be provided with ice dam protection in the form of sheet metal or a product labeled as meeting the requirements of ASTM D 1970.

2. The ice dam protection shall extend at least 30 inches up the roof slope from the roof edge and at least 12 inches up the roof slope beyond the inner face of the exterior wall.

(4) FLASHING. Flashings shall be installed at the junction of chimneys and roofs, in all valleys, and around all roof openings.

(a) Valley flashing. 1. Open valleys. Open valleys shall be flashed with at least No. 28 gauge galvanized, corrosion-resistant sheet metal, 16 inches wide, or a layer of at least 50-pound roll roofing, 16 inches wide, placed over a layer of 15-pound roofing underlayment. Flashing sections shall be overlapped by at least 4 inches.

2. Closed valleys. Where shingles are laced or woven over the valley, the valley shall be flashed with at least one layer of 50-pound roofing, at least 20 inches wide, over the layer of 15-pound roofing underlayment.

(b) Chimney flashing. 1. Chimney crickets shall be installed where the upper side of a chimney is more than 30 inches wide on a sloping roof. The intersection of the cricket and the chimney shall be flashed and counter-flashed to a height of at least 4 inches.

2. Chimneys not exceeding 30 inches wide shall be flashed and counter-flashed to a height of at least 6 inches.

3. Chimney sides shall be flashed to a height of at least 4 inches.

Comm 21.28 Roof and ceiling wood framing.

Unless designed through structural analysis, wood rafters and ceiling joists, and components, shall comply with the requirements of s. Comm 21.02 (3).

(1) ROOF RAFTERS. (a) Ridge boards. 1. Where rafters meet to form a ridge, the rafters shall be attached to a ridge board.

2. The ridge board shall have a depth at least equal to the length of the cut end of the rafter abutting it.

3. Where all rafters are placed directly opposite each other or are offset at the ridge board by less than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 1 inch.

4. Where one or more rafters are offset at the ridge board by more than the thickness of the rafter, the ridge board shall have a nominal thickness of at least 2 inches.

(b) Bearing. The required bearing for wood rafters shall be in accordance with the National Design Specification for Wood Construction published by National Forest Products Association. In no case shall the bearing be less than 1 1/2 inches on wood or metal or less than 3 inches on masonry or concrete.

(2) Anchorage. Roofs shall be anchored to resist horizontal thrust and uplift. Provisions shall be taken to absorb the horizontal thrust produced by the sloping roof, rafters or beams through collar ties installed in the upper third of the roof rafters on every third pair of rafters; or through the use of cross ties connecting beams; or through the use of metal straps or metal plates located at the ridge which tie the roof beams together. Rafters shall be notched to fit the exterior wall plate and fastened to the wall.

Thrust Anchorage of Rafters

Question: *Shouldn't this section require collar ties in the lower one-third of the rafter spans to adequately resist the lateral roof thrust?*

Answer: *No. This section assumes rafter framed roof construction with ceiling joists fastened to the ends of the rafters at the wall plate. Horizontal thrust is resisted by both the collar ties at the upper one-third of the roof and the ceiling joist at the base of the roof. Additionally, the collar ties provide longitudinal roof stability.*

(2m) Cathedral ceilings. In cathedral ceilings, the upper end of the rafters shall be supported by a ridge beam or bearing wall, or thrust restraint shall be provided per s. Comm 21.02.

(3) CEILING JOISTS. Ceiling joists shall be nailed to exterior walls and to the ends of rafters. Where joining over interior parititions, they shall be nailed to the plate or to each other. Where ceiling joists are placed at right angles to the rafters, as in flat or hip roofs, the lookout joist or ties shall be fastened to the parallel ceiling joists or rafters.

(4) VALLEY AND HIP RAFTERS; LADDERS. (a) Valley rafters. Where no bearing is provided under valley rafters at the intersection of 2 roof areas, the valley rafters shall be doubled in thickness and shall be at least 2 inches deeper than the required common rafter to permit full bearing at the beveled end. Where ridges are provided at different elevations, care should be taken to provide vertical support for the interior end of the lower ridge board.

(b) Hip rafters. Where no bearing is provided under hip rafters, the hip rafters shall be of the same thickness as common rafters and shall be at least 2 inches deeper to permit full contact with the jack rafter.

(c) Ladders. Overhangs at gable end walls of more than 12 inches shall be provided with ladders (rafters which extend over the wall) which extend into the structure a distance no less than the length of the overhang. The ladders shall be fastened at the wall. The interior end of each ladder shall be attached to a rafter or truss with a hanger.

(5) ROOF TRUSSES. Metal plate connected wood roof trusses shall be designed in accordance with the Design Specifications for Metal Plate Connected Wood Trusses and the National Design Specification for Wood Construction. Truss members shall not be cut, bored or notched.

(6) NOTCHING AND BORING. (a) General. 1. Notching and boring of beams or girders is prohibited unless determined through structural analysis.

2. Notching and boring of ceiling joists and rafters shall comply with pars. (b) and (c).

(b) Notching. 1. Notches located in the top or bottom of ceiling joists and rafters are prohibited from all of the following:

a. Having a depth exceeding 1/6 the depth of the member.

b. Having a length exceeding 1/3 the depth of the member.

c. Being located in the middle 1/3 of the span of the member.

2. Where ceiling joists or rafters are notched at the ends, the notch may not exceed ¼ the depth of the member.

3. Bird mouth cuts may not exceed 1/3 the depth of the rafter unless the seat cut bears fully on the wall plate.

(c) Boring. 1. Holes bored within 2 inches of the top or bottom of ceiling joists or rafters may not be located in the middle 1/3 of the span of the member.

2. The diameter of a hole may not exceed 1/3 the depth of the member.

3. A hole may not be bored within 2 inches of a notch or another hole.

4. The distance between adjacent holes may not be less than the diameter of the larger hole.

(d) Engineered wood products. Notching or boring of engineered wood products shall be done in accordance with the manufacturer's instructions provided those instructions were

developed through structural analysis or product testing. Trusses shall be anchored in accordance with standards and recommendations published by the Truss Plate Institute.

(7) ROOF SHEATHING, BOARDS AND PLANKING. (a) Plywood sheathing. Plywood sheathing and similar sheathing materials which are rated by the APA shall be grade marked and stamped and limited to the allowable loads and spans indicated in Table 21.28-A.

(b) Roof boards. Roof boards shall comply with the minimum thicknesses shown in Table 21.28-B.

(c) Roof planks. Roof planks shall be tongue and groove or splined and at least 2 inches, nominal, in thickness. Planks shall terminate over beams unless the joints are end matched. The planks shall be laid so that no continuous line of joints will occur except at points of support. Planks shall be nailed or fastened to each beam.

TABLE 21.28-A

ALLOWABLE LOADS AND SPANS FOR PLYWOOD ROOF SHEATHING
CONTINUOUS
OVER TWO OR MORE SPANS AND FACE GRAIN PERPENDICULAR
TO SUPPORTS[1,2,3]

		Maximum Span (inches)		Load (in pounds per square foot)	
Panel Span Rating	Plywood Thickness (inches)	Edges Blocked	Edges Unblocked	Total Load	Live[4] Load
12/0	5/16	12	12	40	30
16/0	5/16, 3/8	16	16	40	30
20/0	5/16, 3/8	20	20	40	30
24/0	3/8	24	20	40	30
24/16	7/16, 1/2	24	24	50	40
32/16	15/32, 1/2, 5/8	32	28	40	30
40/20	19/32, 5/8, 3/4, 7/8	40	32	40	30
48/24	23/32, 3/4, 7/8	48	36	45	35

1 Spans shall be limited to values shown, based on possible effect of concentrated loads.

2 Underlayment, C-C Plugged, sanded exterior type: allowable uniform load based on deflection of L/360 span for spans 24 inches or less is 125 psf; and for spans 48 inches, 65 psf.

3 Plywood sheathing may be installed with face grain parallel to supports in accordance with the "APA Design/Construction Guide", APA, P.O. Box 11700, Tacoma, WA 98411.

4 Assumes 10 psf dead load.

TABLE 21.28-B

MINIMUM THICKNESS OF ROOF BOARDS

	Minimum Net Thickness (inches)	
Rafter Spacing (inches)	Solid Sheathing	Spaced Sheathing
24	5/8	3/4

Subchapter IX —Fireplace Requirements

Comm 21.29 Masonry fireplaces.

Masonry fireplaces shall be constructed of masonry, stone or concrete. Masonry fireplaces shall be supported on foundations of concrete or masonry. Structural walls shall be at least 8 inches thick. Masonry fireplaces shall conform to the following requirements:

(1) FLUE SIZE. The fireplace flue size shall be based on the type of flue and the fireplace opening indicated in Table 21.29.

TABLE 21.29

MINIMUM FLUE SIZE FOR MASONRY FIREPLACES

Type of Flue	Minimum Cross-Sectional Area
Round	1/12 of fireplace opening but not less than 75 square inches
Square or rectangular	1/10 of fireplace opening but not less than 75 square inches

(2) TERMINATION OF CHIMNEY. Masonry fireplace chimneys shall extend at least 3 feet above the highest point where the chimney passes through the roof and at least 2 feet higher than any portion of the dwelling within 10 feet of the chimney.

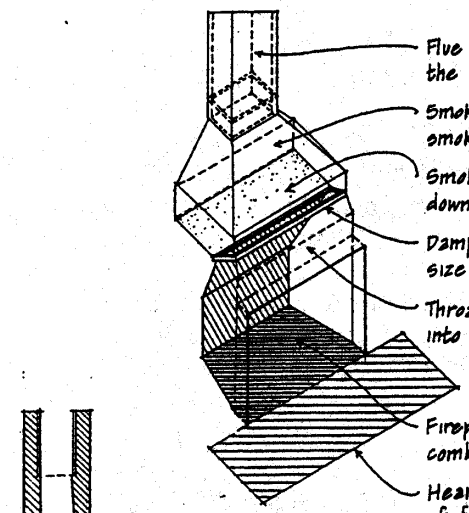
(3) FIREBOX MATERIALS. The firebox shall be of the preformed metal type, at least 1/4 inch thick, or listed by a nationally recognized laboratory; or shall be lined with firebrick, at least 2 inches thick and laid in thin joints of refractory cement. The back and sidewalls of the firebox, including the lining, shall be at least 8 inches nominally thick masonry, at least 4 inches of which shall be solid.

(4) LINTEL. Masonry over the fireplace opening shall be supported by a lintel of steel or masonry.

(5) DUCTS. Warm-air circulating ducts shall be constructed of masonry or metal.

(5m) RETURN AIR GRILLES. Return air grilles shall not be located in bathrooms, kitchens, garages, utility spaces or in a confined space defined under s. Comm 23.06 in which a draft diverter or draft regulator is located.

Commentary

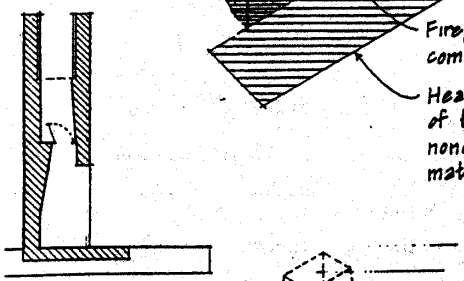


A fireplace should be designed and constructed to:

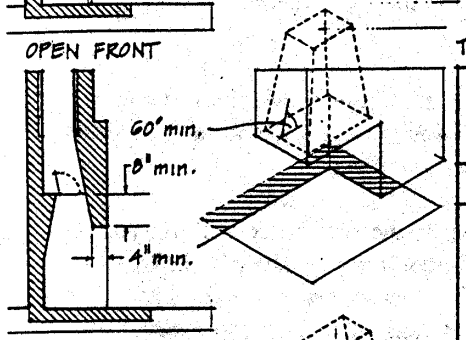
- Sustain the combustion of the fuel
- Draw properly to carry smoke and other combustive by-products to the outside
- Radiate the maximum amount of heat comfortably into the room
- Ensure proper distances from combustible materials.

Thus the dimensions and proportions of a fireplace and its flue, and the arrangement of its components, are subject to the laws of nature and the requirements of the building and mechanical codes.

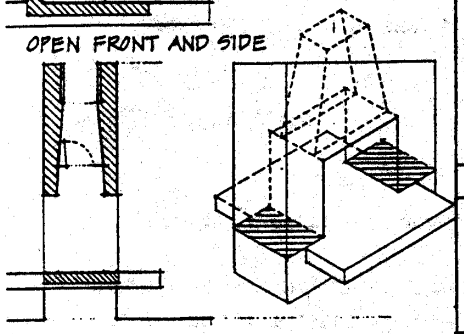
The table below provides typical dimensions for three types of fireplaces.



OPEN FRONT



OPEN FRONT AND SIDE



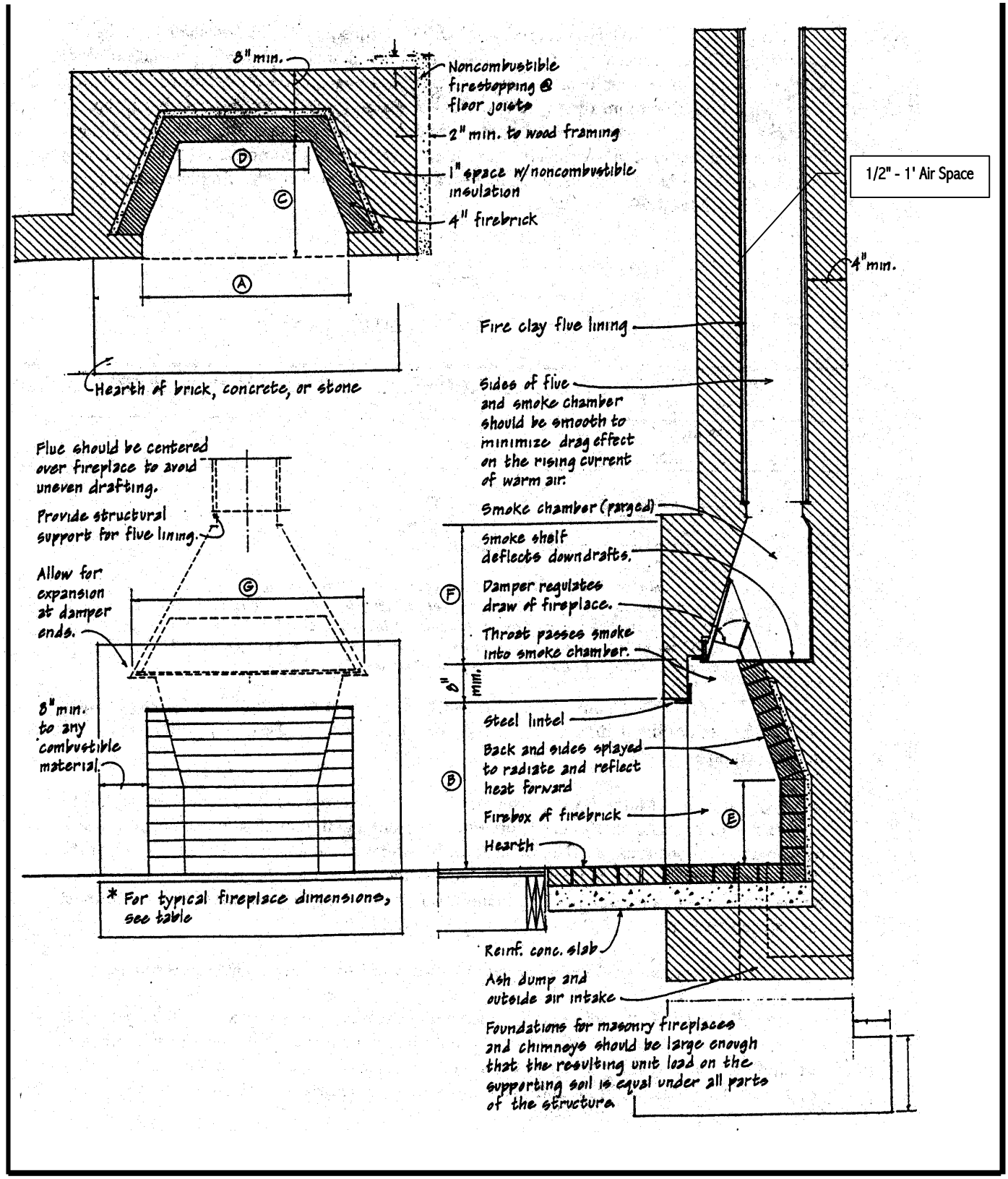
OPEN FRONT AND BACK

Multifaced fireplaces are especially susceptible to drafts in a room; avoid placing their openings opposite an exterior door.

TYPICAL FIREPLACE DIMENSIONS (inches)

Width (A)	Height (B)	Depth (C)	Back width (D)	Vertical back (E)	Smoke chamber (F)	Damper width (G)	Flue size
OPEN FRONT							
24	24	16	11	14	19	32	8 x 12
28	24	16	15	14	21	36	8 x 12
32	29	16	19	14	24	40	12 x 12
36	29	16	23	14	27	44	12 x 12
42	32	16	29	14	32	50	16 x 16
48	32	18	33	14	37	56	16 x 16
54	37	20	37	16	45	60	16 x 16
60	40	22	42	16	45	72	16 x 20
72	40	22	54	16	56	84	20 x 20
OPEN FRONT AND SIDE							
28	24	16					12 x 12
32	28	18					12 x 16
36	30	20					12 x 16
48	32	22					16 x 16
OPEN FRONT AND BACK							
28	24	16					12 x 12
32	28	16					12 x 16
36	30	17					12 x 16
48	32	19					16 x 16

Commentary


8" min.
Noncombustible firestopping @ floor joists
2" min. to wood framing
1" space w/noncombustible insulation
4" firebrick
D
C
A
Hearth of brick, concrete, or stone
1/2" - 1' Air Space
4" min.
Fire clay flue lining
Sides of flue and smoke chamber should be smooth to minimize drag effect on the rising current of warm air.
Smoke chamber (parged)
Smoke shelf deflects downdrafts.
Damper regulates draw of fireplace.
Throat passes smoke into smoke chamber.
F
8" min.
Steel lintel
Back and sides splayed to radiate and reflect heat forward
B
Firebox of firebrick
E
Hearth
Flue should be centered over fireplace to avoid uneven drafting.
Provide structural support for flue lining.
Allow for expansion at damper ends.
G
8" min. to any combustible material.
* For typical fireplace dimensions, see table
Reinf. conc. slab
Ash dump and outside air intake
Foundations for masonry fireplaces and chimneys should be large enough that the resulting unit load on the supporting soil is equal under all parts of the structure.

(6) HEARTH EXTENSION. (a) Masonry fireplaces shall have a hearth extension made of noncombustible material.

(b) The structural support for the hearth and hearth extension shall be a minimum of 4 inches of reinforced concrete.

(c) There shall be no structural framing material within 1 inch of the hearth or hearth extension in any direction. Any wooden forms or supports used during construction shall be removed.

(d) The minimum dimensions of the hearth extension shall be in accordance with Table 21.29-1.

TABLE 21.29-1

HEARTH EXTENSION DIMENSIONS

Fireplace Opening (square feet)	Extension from Fireplace Opening (inches)	
	Side	Front
Less than 6	8	16
6 or greater	12	20

Hearth Extension

Question: *How is the hearth extension measured?*
Answer: *The hearth or hearth extension is measured from the face of the fireplace opening and not from the front of the firebox, spark screen, or glass doors. The face of the fireplace includes any trim materials provided on the front of the fireplace. Earlier editions of the UDC permitted measurement from the firebox, but as of the 1989 Edition, the measurement is to be taken from the* ***face of the fireplace opening***.

(7) DAMPERS. Dampers shall be made of cast iron or at least No. 12 gauge sheet metal. The area of the damper opening shall be at least 90% of the required flue area when in the open position.

(8) HOODS. Metal hoods, used in lieu of a masonry smoke chamber, shall be constructed of at least No. 19 gauge corrosion-resistant metal with all seams and connections of smokeproof construction. The hood shall be sloped at an angle of 45° or less from the vertical and shall extend horizontally at least 6 inches beyond the firebox limits. Metal hoods shall be kept a minimum of 18 inches from the combustible materials unless approved for reduced clearances.

Note: The department will accept dampers and hoods listed by nationally recognized laboratories.

(9) FLUE LINERS. (a) Flue liners shall be installed in accordance with s. Comm 21.30 (7) and this section.

(b) Flue liners shall start at the top of the fireplace throat and extend to a point at least 4 inches above the top of the chimney cap.

(c) Firebrick may be used in the throat of the fireplace as an inlet to the flue liner.

(10) CLEANOUT OPENINGS. Fireplaces with ash dumps shall be provided with cleanout openings at the base. Doors and frames of the opening shall be made of ferrous materials.

(11) MANTEL SHELVES AND COMBUSTIBLE TRIM. Woodwork or other combustible materials shall not be placed within 6 inches of the fireplace opening. Combustible materials located within 12 inches of the fireplace opening shall not project perpendicularly more than 1/8 inch for each inch distance from the opening.

(12) FRAMING AROUND FIREPLACES. Combustible materials located near fireplaces shall be installed in accordance with s. Comm 21.30 (9).

Framing Around Fireplaces

Question: *This section refers to 21.30(9) which requires 2-inch clearances from fireplace masonry to combustibles. In some cases, the block and brick may cover an entire wall. In such a case, is it necessary to maintain the 2-inch clearance from the entire wall?*

Answer: *Because of the expected heat dissipation in such an installation, the department will accept the ends of the beams and headers to be placed without a 2-inch clearance if at least 12 inches of solid masonry is also provided between the member and the firebox or chimney flue. If the wood structural member is supported in the masonry, it must be fire cut or a self-releasing device must be used as required by s. Comm 21.26(9)(d).*

Note the requirement for clearances to a fireplace applies only to framing. Other combustible elements such as mantles, trim, and flooring would need to comply with the s. Comm 21.29(11), as well as the hearth requirements of s. Comm 21.29(6).

(13) CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exeed one-inch projection for each brick course.

Comm 21.30 Masonry chimneys.

Masonry chimneys shall conform to the following provisions:

(1) MATERIALS. No masonry chimney shall rest upon wood. The foundation shall be designed and built in conformity with the requirements for foundations. Masonry chimney walls shall be at least 4 inches in nominal thickness. Hollow cored masonry units may be used to meet the 4-inch nominal thickness requirement.

(2) FLUE SIZE. Chimney flues for appliances shall be at least equal in area to that of the area of the connector from the appliance.

(3) MULTIPLE FLUE SEPARATION. When more than one flue is contained in the same chimney, a masonry separation of at least 4 inches nominal in thickness shall be provided between the individual flues. The joints of adjacent flue linings shall be staggered by at least 7 inches.

(4) CORBELING. Unless designed through structural analysis, masonry chimneys shall not be corbeled from a wall more than 6 inches nor shall a masonry chimney be corbeled from a wall less than 12 inches in nominal thickness unless it projects equally on each side of the wall. The corbeling shall not exceed one-inch projection for each brick course.

(5) INLETS. Inlets to masonry chimneys shall enter the side and be provided with thimbles. Thimbles shall be at least No. 24 manufacturer's standard gauge (0.024 inch) or 5/8-inch thick, refactory material. Each chimney shall have an inlet installed at the time of construction.

(6) CLEAN-OUT OPENING. Every masonry chimney shall be provided with a clean-out opening at the base. Such openings shall be equipped with metal doors and frames arranged to remain closed when not in use. Clean-out openings shall be located below the lowest inlet to the flue.

(7) FLUE LINERS. (a) Masonry chimneys shall be lined with a material that will resist corrosion, softening and cracking at temperatures up to 1800°F, such as vitrified clay sewer pipe or minimum 5/8-inch thick fire clay lining material.

(b) All flue liners shall be laid in a full bed of refractory mortar or refractory cement.

(c) Variations in inside and outside dimensions shall not exceed 1/4 inch for clay flue liners.

(d) There shall be a minimum clearance of 1/2 inch and a maximum clearance of 1-inch between the flue liner and the chimney walls.

(e) Unless serving a masonry fireplace under s. Comm 21.29, the flue liners shall commence at the chimney footing.

Flue Liners

Question: *If a stainless steel flue liner is used, what gauge stainless steel may be used to line a masonry chimney?*

Answer: *Stainless steel of 22 gauge or thicker is acceptable.*

(8) CHIMNEY CAPS. Chimneys shall be provided with precast or cast-in-place concrete chimney caps. Chimney caps shall have a minimum thickness of 2 inches, shall slope outwards away from the flue, and shall provide a one-inch overhang and drip edge on all sides. A slip joint shall be installed between the flue and the cap. The slip joint shall be filled with 1/4 inch felt or similar material and shall be caulked with high-temperature caulk or similar material to prevent water infiltration.

(9) CLEARANCE TO COMBUSTIBLES. (a) The minimum clearance between combustibles and masonry chimneys which have any portion located within the exterior wall of the dwelling shall be 2 inches. The minimum clearance between combustibles and masonry chimneys which have all parts completely outside the dwelling, exclusive of soffit or cornice areas, shall be one inch.

(b) Except as required under pars. (c) and (d), the clearance spaces shall remain completely open.

(c) The clearance spaces between chimneys and wood joists, beams, headers or other structural members shall be fireblocked at each floor level from chimney footing all the way to the roof flashing with galvanized steel, at least 26 gage thick or with noncombustible sheet material.

(d) Noncombustible material shall be used to prevent entry of debris into the clearance spaces.

Fireblocking of Chimneys

Question: *The Uniform Dwelling Code requires 2 inches of clearance between combustible headers, beams, rafters, joists and studs and the outside face of a interior chimney (1 inch for an exterior chimney). Does subs. Comm 21.08(1) on fire separation also apply where this rule states "holes around ducts and pipes shall also be fire stoped"?*

Answer: *Yes. It is the intent for s. Comm 21.08(1) to apply to the 2-inch or 1-inch clearance between the chimney and the structural members. Noncombustible fire blocking material must be used. In addition, insulation is not acceptable for fire blocking metallic chimneys or vents as this would cause "hot spots" to occur and most likely harm them and/or void the manufacturer's testing.*

Comm 21.32 Factory built fireplaces.

Factory-built fireplaces consisting of a fire chamber assembly, one or more chimney sections, a roof assembly and other parts shall be tested and listed by a nationally recognized testing laboratory.

(1) FIREPLACE ASSEMBLY AND MAINTENANCE. The fireplace assembly shall be erected and maintained in accordance with the conditions of the listing.

(a) All joints between the wall or decorative facing material and the fireplace unit shall be completely sealed, firestopped or draft-stopped with a noncombustible caulk or equivalent.

(b) Doors installed on factory built fireplaces shall conform with the terms of the listing and the manufacturers installation instructions for the fireplace unit.

(2) DISTANCE FROM COMBUSTIBLES. Portions of the manufactured chimney extending through combustible floors or roof/ceiling assemblies shall be installed in accordance with the distances listed on the chimney in order to prevent contact with combustible materials.

(3) HEARTH EXTENSIONS. Hearth extensions shall be provided in accordance with the manufacturer's listing. Where no hearth extension is specified in the listing, a hearth extension shall be provided in accordance with s. Comm 21.29 (6).

Factory-Built Fireplaces

The department conducted an investigation regarding factory-built fireplace installations. As a result of the investigation, it was felt special consideration should be given to two important installation requirements that are especially important to proper operation of such fireplaces.

Per s. Comm 21.32, factory-built fireplaces and their specified chimneys shall be tested and listed by a nationally recognized testing laboratory. Furthermore, the fireplace assembly and chimney shall be erected and maintained in accordance with the conditions of the listing. Currently acceptable testing and listing laboratories for this and other purposes are listed below. Not all will test all classes of appliances.

- *Underwriter's Laboratories (UL)*
- *Electrical Testing Labs of New York (ETL-NY)*
- *Energy Testing Labs of Maine (ETL-MAINE)*
- *Canadian Standards Association (CSA)*
- *Product Fabrication Service (PFS)*
- *Warnock Hersey*

Specific emphasis should be placed on inspection of the construction gap between the front of the fireplace unit and the finish material or facia. Most, if not all, manufacturers require the gap be filled with noncombustible caulk or equivalent. The fear, although not specifically

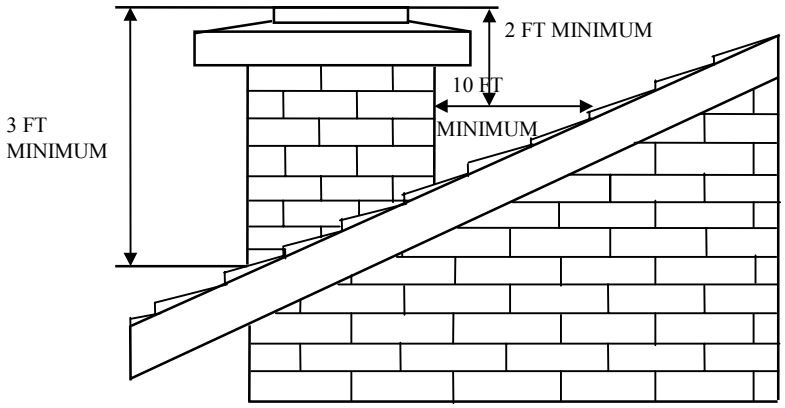
verified by our investigation, is that hot gases or sparks can migrate out of the fire box through such an opening and eventually cause ignition of the unprotected combustibles behind the facia. Improper drafting could increase the likelihood of such an occurrence.

Typically the crack between the fireplace and hearth must also be properly sealed against entry of sparks and coals if there is combustible flooring below.

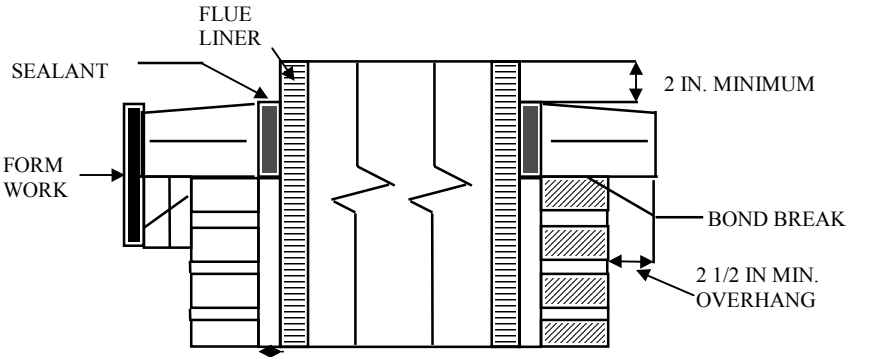
The use of any add-on items should be closely checked as to whether they are listed for that particular fireplace. Be especially suspicious of retrofitted stoves or fireplace inserts which can cause severe problems if the fireplace was not designed for them.

Also, fireplace doors should be checked to verify that they are of a type made by the fireplace manufacturer and approved for installation on that model. Oversize doors could restrict combustion air supply, block air circulation vents or slots that cool the unit or even deflect heat or hot gases laterally into the construction gap between the front of the unit and the surrounding facia as described above.

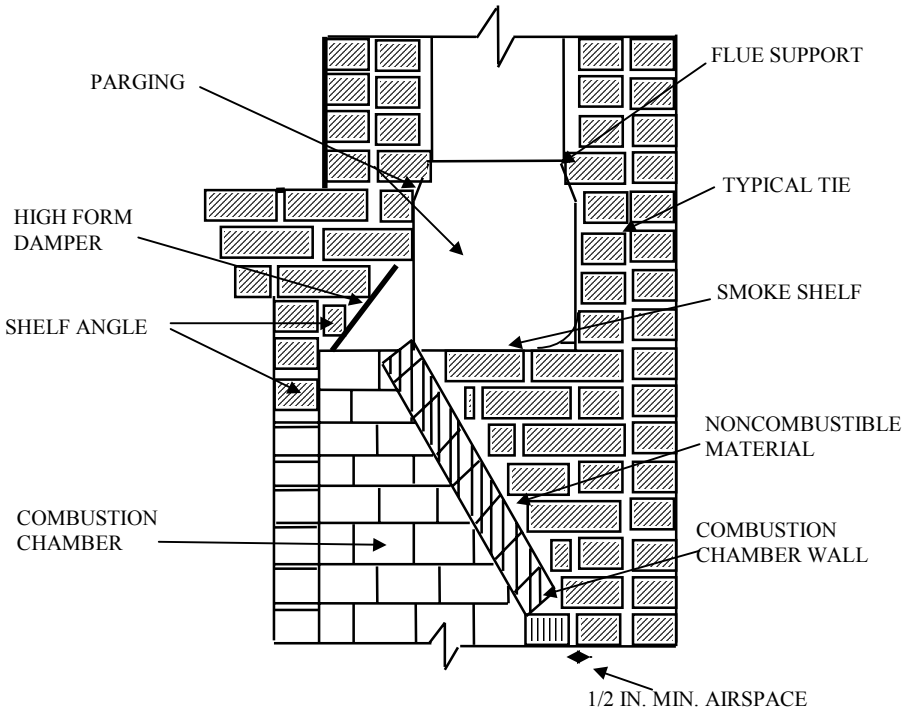
In conclusion, all manufacturer's installation requirements should be followed. An inspector is entitled to request a copy of manufacturer's installation instructions, per s. Comm 20.09(4)(b), in order to conduct proper inspections.

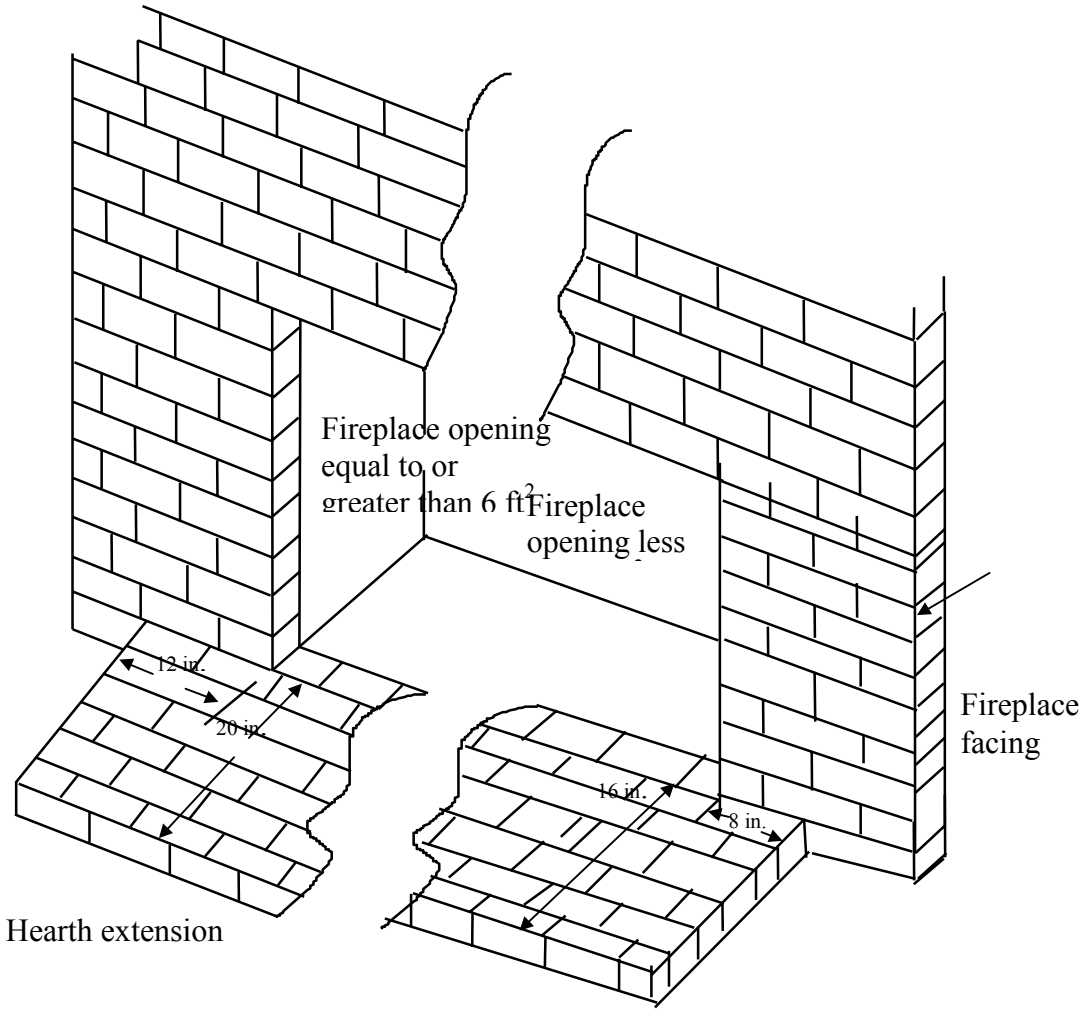


Building Code Dimension



CHIMNEY CAP





Fireplace hearth extension requirements

Question: *Many pre-manufactured fireplace installation instructions require a noncombustible insulating material be placed between the hearth extension finish material and the combustible floor. Is this noncombustible insulating board required by the UDC?*

Answer: *Indirectly, yes. Section Comm 21.32(1) requires the entire fireplace installation be installed per the manufacturer's listing. The hearth extension design is part of the listing. The insulating board specifications vary between fireplace manufacturers. For example, some "Preway" Models requires either of two of its products, "Preway" HE 36-1 or HE 3624. An alternative material should be equal to 3/4-inch thick noncombustible insulating material with a thermal conductivity of k = 0.55 (Btu)-(In)/(Hr)(sq ft) (^{o}F). As an alternative to k-value, a 3/4-inch noncombustible material with a thermal conductance C = .73 or thermal resistance R = 1.36 is acceptable. Besides the Preway products mentioned, other trade name products such as "Celotex CV 230", "Micore" and "Spec 300" boards may also be acceptable (check k-values).*

Gas Fireplaces

Question: *Are gas-only fireplaces required to have a hearth extension per the UDC?*

Answer: *No. Gas-only fireplaces are covered by s. Comm 23.04 as a gas appliance and need to be installed per their listing, which typically may not require a hearth extension.*

Factory-Built Fireplace Chimneys

Question: *Does the requirement of s. 23.045(3)(a)1., that factory-built chimneys be tested to 2,100dF ("high-temperature" rated) if connected to a solid-fuel appliance, apply to a factory-built fireplace?*

Answer: *No. Section 23.045 applies to solid-fuel appliances other than those covered by other sections of the code such as masonry and factory-built fireplaces (ss. Comm 21.29 through 21.32). The proper chimney for a factory-built fireplace is the one it was tested and listed with and is normally shipped with the unit. It is possible that such listed fireplace assemblies will have a lower temperature chimney.*

Subchapter X —— Construction in Floodplains

Comm 21.33 Construction in floodplains.

(1) GENERAL. Where dwelling construction is allowed by local zoning ordinances to take place in floodfringe areas of floodplains, the dwelling shall meet the requirements of this subchapter.

Note: The department of natural resources (DNR) and the federal emergency management agency (FEMA) also have regulations that apply to construction in floodfringe areas.

(2) ELEVATION. (a) General. Except as provided in pars. (b) and (c), all dwellings constructed within a floodfringe area shall be elevated so the lowest floor and all basement floor surfaces are located at or above the base flood elevation.

(b) Certified floodproof basements. Floodproof basements may have the top of the basement floor no more than 5 feet below the base flood elevation provided the basement is designed by a registered architect or engineer to be watertight and impermeable. No limitation is placed on the use or occupancy of a certified floodproof basement by the provisions of this subchapter.

(c) Other enclosed spaces. 1. Enclosed spaces not meeting the requirements of par. (b) are allowed at any depth below the base flood elevation provided the spaces are used only for one or more of the following purposes:

a. Means of egress.

b. Entrance foyers.

c. Stairways.

d. Incidental storage of portable or mobile items.

2. Fully enclosed spaces used only for those purposes listed in subd. 1. shall be designed to automatically equalize the hydrostatic pressure on exterior walls by allowing the entry and exit of floodwaters. Designs for meeting this requirement shall be certified by a registered architect or engineer or shall meet all of the following requirements:

a. There shall be at least two pressure relieving openings and the openings shall have a total net area of not less than one square inch for every square foot of enclosed area subject to flooding.

b. The bottom of all openings shall be no more than 12 inches above grade.

c. Openings may not be equipped with screens, louvers, valves or other coverings or devices unless such devices permit the automatic entry and discharge of floodwaters.

(3) CERTIFICATION OF ELEVATION. A registered land surveyor, architect or engineer shall certify the actual elevation in relation to mean sea level of the lowest structural member required to be elevated by the provisions of this subchapter.

(4) ANCHORAGE. The structural systems of all dwellings shall be designed, connected and anchored to resist flotation, collapse or permanent lateral movement due to structural loads and stresses at the base flood elevation.

(5) PROTECTION OF ELECTRICAL AND MECHANICAL SYSTEMS. Electrical and mechanical equipment shall be placed above the base flood elevation or shall be designed to prevent water contact with the equipment in case of a flood up to the base flood elevation.

(6) CONSTRUCTION MATERIALS AND METHODS. All dwellings constructed in floodplains shall be constructed using materials and methods designed to minimize flood and water damage.

Comm 21.34 Construction in coastal floodplains.

(1) GENERAL. All dwellings constructed in coastal floodplains shall be designed by a registered architect or engineer and shall meet the requirements of this section and section Comm 21.33.

(2) ELEVATION. All dwellings constructed in a coastal floodplain shall be elevated so the lowest portion of all structural members supporting the lowest floor, with the exception of mat or raft foundations, pilings, piling caps, columns, grade beams and bracing, is located at or above the base flood elevation.

(3) ENCLOSURES BELOW BASE FLOOD ELEVATION. Enclosures below the base flood elevation in a coastal floodplain may not be used for human occupancy and shall be free of all obstructions, except for non-loadbearing walls and partitions. Non-loadbearing walls and partitions below base flood elevation shall be constructed to break away without causing any structural damage to the elevated portion of the dwelling or foundation system due to the effect of wind loads and water loads acting simultaneously.

(4) FOUNDATIONS. All dwellings located in a coastal floodplain shall be supported and anchored on pilings or columns. The piling or column shall have adequate soil penetration to resist combined water and wind loads at the base flood elevation. Piling or column design shall consider the effect of scour of soil strata. Mat or raft foundations to support columns may not be used where soil under the mat or raft is subject to scour or other erosion from wave flow conditions.

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